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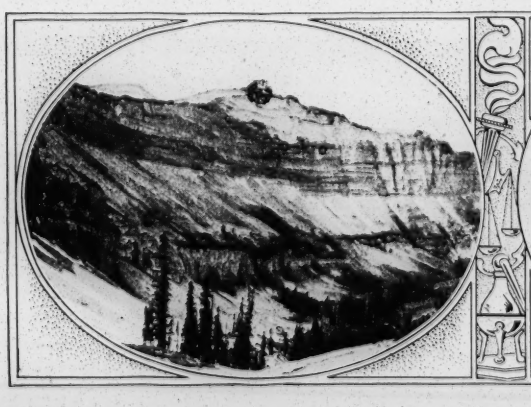

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VOL. XIII, No. 12 WASHINGTON DECEMBER, 1902

THE NATIONAL GEOGRAPHIC MAGAZINE

VOLCANIC ERUPTIONS ON MARTINIQUE AND ST VINCENT*

BY PROFESSOR ISRAEL C. RUSSELL

OF THE NATIONAL GEOGRAPHIC SOCIETY EXPEDITION TO WEST INDIES

THE continuation of activity in the case of Mont Pelée and La Soufrière of St Vincent makes it evident that it is yet too early to write a final report on their recent eruptions. What may be termed a first approximation, however, to the significance of the observations concerning them already in hand,† may be of interest to the members of the National Geographic Society.

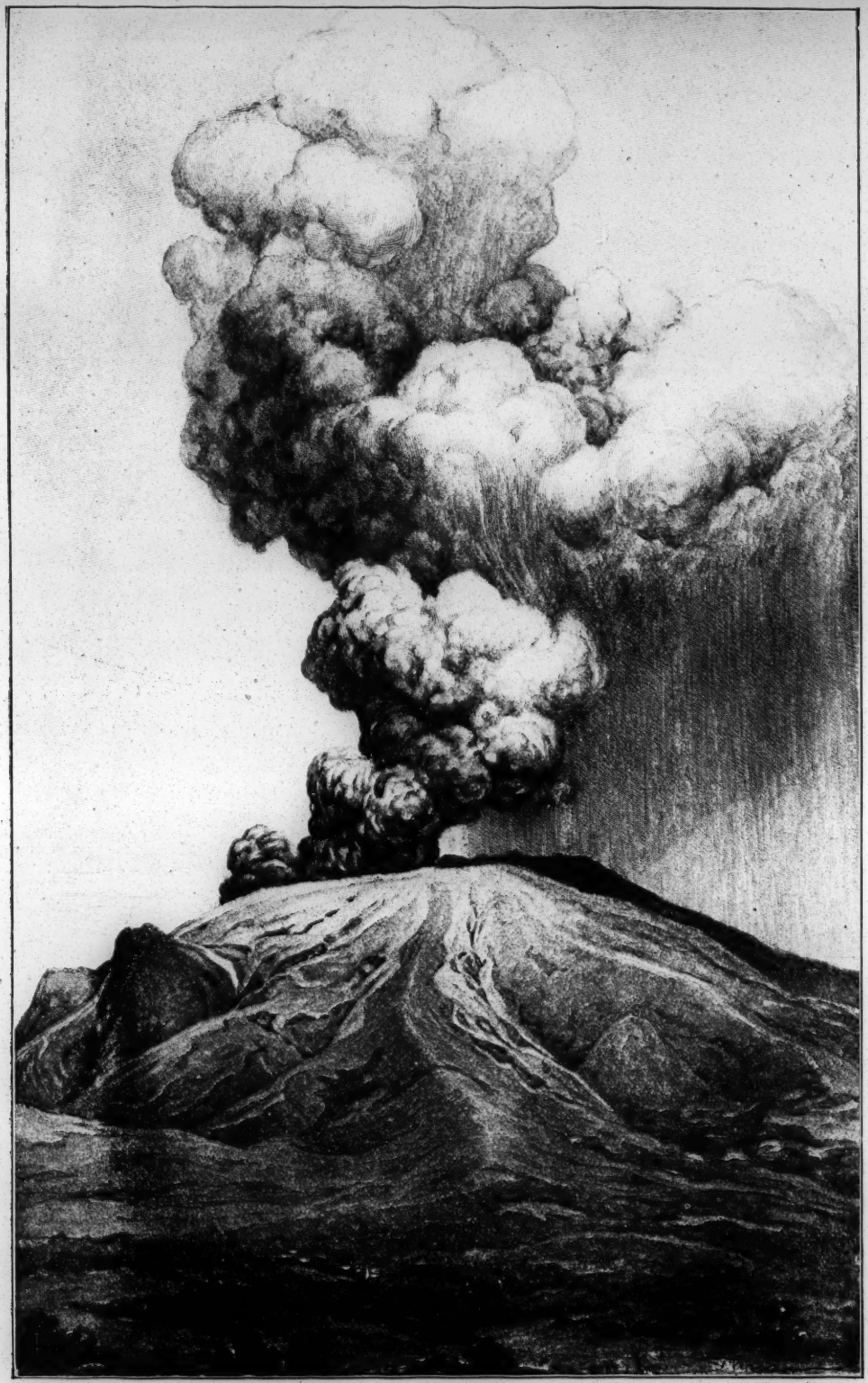
The Number of Active Craters.—The first question to which an answer is sought concerning both Mont Pelée and La Soufrière is: Have the recent eruptions occurred from a single and essentially a summit crater in each instance, or have secondary or subcraters been opened on the sides of the volcanoes, which had a connection with their conduits? In the case of La Soufrière no differences of opinion in this connection have arisen among the several observers who have visited the mountain. The eruptions have all occurred in a single crater, the so-called Old crater, in distinction from the one formed in 1812. This crater is near the summit of the mountain, but is partially encircled on the northeast by a remnant of a much older and far larger crater, which corresponds with Mont Summa at Vesuvius, and may be termed a "*somma*."

At Mont Pelée there is also a *somma*, and on its southwest side is the crater known as Étang Sec, which is now in eruption. A smaller summit crater, formerly occupied by Lac des Palmistes, occurs to the northeast of the one now active, and corresponds in a general way with the crater of 1812 on St Vincent. While several observers have reported the existence of at least two subcraters—one on the east and the other on the southwest slope of Mont Pelée,

* The illustrations in this number of the West Indian volcanic phenomena, some of them republished from other reports, form a valuable supplement to the very complete and graphic set of illustrations taken by Robert T. Hill and Israel C. Russell and published in the July number of the NATIONAL GEOGRAPHIC MAGAZINE.—EDITOR.

† A list of the papers referred to is presented at the end of this essay.

the former termed the "Falaise crater" and the latter the "Rivière Blanche crater"—a careful consideration of the evidence presented fails to show that these are true centers of eruption having deep sources. Great explosions have occurred, however, at each of the localities referred to, which have thrown large quantities of dust and mud to a height of several hundred feet, and sent out vast volumes of steam to a height of many thousands of feet; but these phenomena are seemingly the same, although marked by greater energy, as have been observed in a large number of instances on both Martinique and St Vincent, where the hot dust, lapilli, stones, etc., ejected from the summit crater, have accumulated to a great depth and been invaded by surface water. While the subcraters mentioned should not in my opinion be considered as true volcanoes, they simulate many of the phenomena attending actual eruptions from deep conduits. The columns of heavily dust- and mud-charged steam which arise from them have the convoluted or cauliflower structure, and at times expand at the top and take on mushroom shapes, in much the same manner as do the columns of steam, heavily charged with rock fragments, that are blown into the air from a primary crater. In each case the proximate cause is the same, namely, a steam explosion. The solid material blown into the air in each instance is also of the same nature (for the reason, as it seems to me, that the hot dust and stones, to which the superficial explosions are due, were supplied by the eruption of the summit crater). Since the observed phenomena are so similar, it may be asked, What is the crucial test by which a true crater may be distinguished from a pseudo-crater? To formulate a definite answer to this question is difficult. Perhaps the best reply that can be offered is that the pseudo-craters are later in the time of their appearance than the main eruptions which supplied the hot material necessary for their production, and that they occur when the topographic conditions previous to the eruptions favored the accumulation of a deep deposit of hot débris. In addition, on both Martinique and St Vincent a complete gradation in size and energy of the superficial steam explosions has been observed, ranging from small geyser-like spoutings, such as have occurred at hundreds of localities in valleys that were deeply filled with hot débris, and even on broad and comparatively smooth surfaces covered with a thick sheet of similar material, up to the markedly energetic explosions in the valleys of the Falaise and Rivière Blanche. In many instances the smaller surface explosions have been observed to follow heavy rains, and the same is true also of the larger explosions referred to. The larger explosions from the summit crater, on the other hand, are more energetic than any that can without doubt be referred to the pseudo-craters. The minor eruptions from the summit crater, however, may be due to precisely the same immediate cause as the eruptions of the pseudo-crater, namely, the access of surface water to highly heated rocks, so that an apparently complete sequence may be observed between the escape of steam from hot débris and the discharges from true volcanic conduits. It is thus seen that the discovery of the crucial test asked for is difficult, and the final decision, if one is reached, must rest on a judicial balancing of all the evidence and the weight to be given to the judgment of individual observers. An instructive fact furnished by the pseudo-crater (even when the larger and, as some persons may think, questionable examples are not considered) which has a bearing on the theories of the ultimate causes of volcanic eruptions, is the close similarity, and in fact identity, that exists between the explo-



Mont Pelée from Vivé, May 27

The great cloud of steam and smoke rose cauliflower shaped from the summit crater to a height of from two to three miles. The descending shower of rain and ashes shows on the right

Drawn by George Varian. Republished from McClure's Magazine

The Night Eruption as Seen from the Road Going South from Vivé toward Assier

Drawn by George Varian. Republished from McClure's Magazine

sions due to surface water gaining access to beds of hot débris and the explosions in the summit portions of true volcanic conduits. In the former instances surface water descends into hot rock débris; and, from the fact that water is present in the superficial portion of the earth's crust, it seems equally manifest in the latter instance that highly heated rock rises from deep within the earth and meets the surface waters. In each instance steam explosions result.

Variation in the Eruptions of the Primary Craters.—The variations presented by the steam columns which ascend from active volcanoes—of which the so-called *pine tree* of Vesuvius is a well-known example—and which in many instances afford the most spectacular of the awe-inspiring phenomena associated with them, have been described by several observers who have recently visited Martinique and St Vincent, but most graphically by George Kennan. The variations referred to are indicative of what takes place in an active crater and in the upper part of the conduit leading to it, and furnish evidence in reference to the changes there in progress. A classification of the various phases presented by the steam column rising from Mont Pelée has been presented by the gifted traveler just referred to, which is instructive.

"The vapor column ascending from Mont Pelée," writes Kennan, "varies greatly from day to day and sometimes from hour to hour, not only in density, but in color, form and general appearance. In its varying aspects it may be described as follows:

"1. The vapor of quiescence: a slowly ascending column of pure white steam, which has neither sharp, clearly defined outlines, nor puff-like convolutions, and which suggests steam rising from the hot water of a geyser basin or from the escape-pipe of a big ocean steamer."

The explanation of the account of such a column from a crater of the type of the one at the summit of Mont Pelée seems to be that the top of the lava column is well below the bottom of the crater, and that the hot rocks are discharging steam, owing to the contact with them of water percolating in from the crater walls or falling of rain. The generation of steam is a surface phenomena, and due essentially to the same cause as the escape of steam from hot débris ejected by a volcano and accumulating in valleys, etc. The notable feature is the absence of convolutions and more or less individualized fleece-like masses in the ascending column, such as are produced by small steam explosions from liquid lava, as is frequently the case at Vesuvius.

"2. The vapor of moderate activity: a column of greater density and somewhat darker color, which rolls and unfolds a little as it rises, and looks like steam mixed with brownish or yellowish smoke from the chimney of a manufactory."

This stage may reasonably be supposed to indicate conditions similar to those mentioned in the first instance, but more intense. A considerable volume of water gaining access to the deep funnel-shaped crater might not be vaporized before descending to the summit of the column of liquid or but partially congealed column of rock within the conduit, and energetic explosions result. The steam columns indicative of moderate activity thus correspond with the columns produced by the maximum explosions of pseudo-craters. The inner slope of the crater of Mont Pelée is precipitous, and, as several observers have reported, portions of its walls overhanging. The fall of blocks of rocks from the crater walls would no doubt cause a conspicuous column of dust-laden steam to ascend.

"3. The vapor of dangerous activity: a sharply defined dark-yellow column of what appears to be liquid mud,

The Smoke from the Top Crater rising on May 30 to a Height of Six Miles

Drawn by George Varian. Republished from McClure's Magazine

which boils out of the volcano in huge rounded masses, swelling and evolving in immense convolutions as it rises—one gigantic mud bubble breaking up out of another in turn—until over the crater there stands a solid opaque pillar of boiling, unfolding, evolving mud-vapor five hundred feet in diameter and eight or ten thousand feet in height."

When such a débris-charged steam column rises from a crater there is no question as to the presence of a conduit leading down deep into the earth. The pseudo-craters seem never to reach such intensity.

"4. The vapor of great eruptions: a straight-sided shaft of very black smoke (dust-charged steam), which shoots up out of the crater with a tremendous velocity, like the smoke of a colossal piece of artillery fired heavenward. This shaft goes to a height of fifteen or twenty thousand feet, and then mushrooms out laterally, so as to cover a circle fifty miles or more in diameter, with a volcanic canopy which is as dark as the blackest thunder cloud and which shuts out the light of day like a total eclipse. The projectile force in eruptions of this kind is so great that it throws the black vapor far above the influence of the trade winds, and the advancing edge of the volcanic mantle moves swiftly eastward two miles or more above the fleecy trade-wind clouds that are drifting in the opposite direction."

In the making of such a column as just described the volume of water and of comminuted rock required is enormous. The volume of the column is in the neighborhood of four billion cubic feet.

If 1 per cent of the column is solid matter it equals 40,000,000 cubic feet, equals 3,000,000 tons.

If 10 per cent of the column is solid matter it equals 400,000,000 cubic feet, equals 30,000,000 tons.

To be sure, we have no accurate measures, our information being almost entirely qualitative; but as such a column as is referred to has been observed to reach a height by estimate of 10,000 feet in two minutes, it may seemingly be safely assumed that it reached its full development in less than five minutes. The coarser of the solid matter first shot out then begins to fall, and the form of the column is maintained by new matter driven upward from the crater. Thus during each five minutes of an eruption some 4,000,000,000 cubic feet of débris-laden steam were expelled from the crater. The average duration of such eruptions is not known, but in certain instances continued for several hours. During each hour that Mont Pelée or

"Bread-Crust" Volcanic Bomb, Mt Pelée (see page 424)

Height of specimen, 2 feet 2 inches. From a photograph by Dr E. O. Hovey. Republished from the Bulletin of the American Museum of Natural History

St Pierre. Ruins of the Great Distillery in the Fort Quarter of the City, Showing Holes in the Iron Tanks due to Volcanic Bombardment

From a photograph by Dr E. O. Hovey. Republished from the Bulletin of the American Museum of Natural History

La Soufrière was in full blast something like 48,000,000,000 cubic feet of dust- and stone-laden steam were driven out. Only guesses can be made as to the amount of solid matter the steam contained. Shall we assume 1 per cent or 10 per cent? Most observers would agree, I fancy, not only that the latter was nearer the truth than the former estimate, but that the true measure is in excess of the larger of the two.

The material extruded in a solid condition, as will be shown later, is fresh lava which came from deep within the earth; but mingled with it are rock fragments that were torn from the walls of the conduits through which the discharges occurred. The per cent of old lava among the ejected solids seems to be greater on St Vincent than on Martinique. In harmony with this is the larger size of the crater of La Soufrière in comparison with that of Mont Pelée.

The columns of steam of Kennan's type No. 4 thus show that great volumes of rock are rising from deep within the earth and being blown into the air. If, as seems probable, the energy displayed by steam columns of the No. 2 type is all that can be supplied by the steam produced from rain and percolating water in the upper part of the conduit, it follows that during explosions of the No. 3 type both rock and steam are rising from a depth in the volcanic conduits. Presumably then, during eruptions of the types No. 3 and No. 4 molten rock is being forced up within the conduit of a volcano and,

St Pierre. Near view of one of the holes. The material of the tanks is quarter-inch boiler iron (see page 425)

From a photograph by Dr E. O. Hovey. Republished from the Bulletin of the American Museum of Natural History

owing to relief of pressure as it rises, the steam dissolved in the molten magma escapes with tremendous violence. There are thus two sources for the steam which furnish the energy displayed in the summit portions of ascending lava columns—one from the rain and percolating water, and the other from a deeper but unknown source. But this attempt to follow the volcanic conduits downward in fancy has brought us to the region of speculation and it is time to stop, at least for the present.

To the four types of volcanic-steam columns described above, a fifth might be added to include volcanic explosions like that of Krakatoa.

Products of the Eruptions.—The material discharged from Mont Pelée and La Soufrière may be divided into two portions: First, steam and gases, and, second, solid rock débris. Up to the present time no observations indicate that molten rock has been extruded; that is, no lava streams have flowed over the surface from the crater of either volcanoes or issued from fissures in their sides.

As to the discharge of vast volumes of steam, there is no difference of opinion to be formed in the various reports already rendered. Observers who have visited the craters from which the recent eruptions came, and have even ventured within them, report only faint traces of gases. The conditions, however, between the time when a crater is quiescent and when violent explosions occur

within it are no doubt different, and as yet but little evidence concerning the gases that may have been present during the times of most violent activity has been obtained. The most that can be accepted in this connection is: a plainly perceptible odor of sulphurous acid noticeable in the air even at a distance of some 8 miles at sea, when the volcanoes were in a comparatively mild state of activity, and while walking over the débris they showered on their respective islands. A much fainter odor of sulphureted hydrogen is reported to have been present, as for example, among the ruins of St Pierre, but whether due to gas emitted from the volcano or arising from organic matter buried beneath the still hot débris is not clear. The presence of carbon dioxide, although asserted or surmised to have been discharged during the greater eruptions, has not been proven. The consideration of all the available evidence points strongly to the conclusion that steam was the chief vaporous or gaseous substance emitted, but mingled with it were minor quantities of sulphurous and no doubt other gases.

In the above connection it should be noted that flames above the summit of both Mont Pelée and La Soufrière have been reported by several trustworthy witnesses. If the appearances referred to were in reality flame, and not glowing dust or the reflection of the light from incandescent rocks on vapor, it is evident that inflammable gases were present. No spectroscopic observations seem to have been made, however, and until this is done the evidence as to the presence of inflammable gases in notable quantity must seemingly be received with caution.

The reports that Mont Pelée and La Soufrière discharged mud are probably correct so far as would appear from a distance, yet the true meaning would seem to be that such eruptions were of the nature of the explosions in the pseudo-crater or in the true craters during intervals between the eruptions from a deep source. Hot dust and lapilli accumulating in a crater during quiescent stages would furnish most favorable conditions for the producing of superficial explosions where rain occurred or springs entered a crater from its sides, as has been observed, and would produce eruptions similar to those of the pseudo-crater, and mud flows might result. It is evidently not to be inferred that either of the volcanoes in question has erupted mud from a deeply seated source.

The solid matter discharged from Mont Pelée and La Soufrière is almost entirely in the condition of angular fragments varying in size from those weighing in the neighborhood of one thousand tons to the finest of dust particles. The fragmental material is of two classes: First, fragments of the rocks torn from the walls of the conduits through which the upward rush of débris-charged steam occurred; and, second, fragments of hardened lava which had been forced upward into the conduits in a plastic condition and shattered and blown out by the escaping steam. In addition to the angular fragments of fresh lava, minor quantities of more or less spherical masses of similar material, which were projected into the air while yet moderately plastic, have also been observed. While the term *volcanic bomb* has been applied to much of the ejected material, it is evident that only the somewhat spherical masses referred to deserve to be so called, and even in such instances there is doubt as to the propriety of using the term. Typical volcanic bombs have a round or oval form, with extended and spirally twisted projections at the ends of the longer axis, the spherical or more commonly oval form and the spirally twisted extremities being due to the rotation of the mass during its aërial flight and while yet plastic. No

Boys Carrying Water to Refugee Camp, Georgetown, St Vincent, May 27, 1902

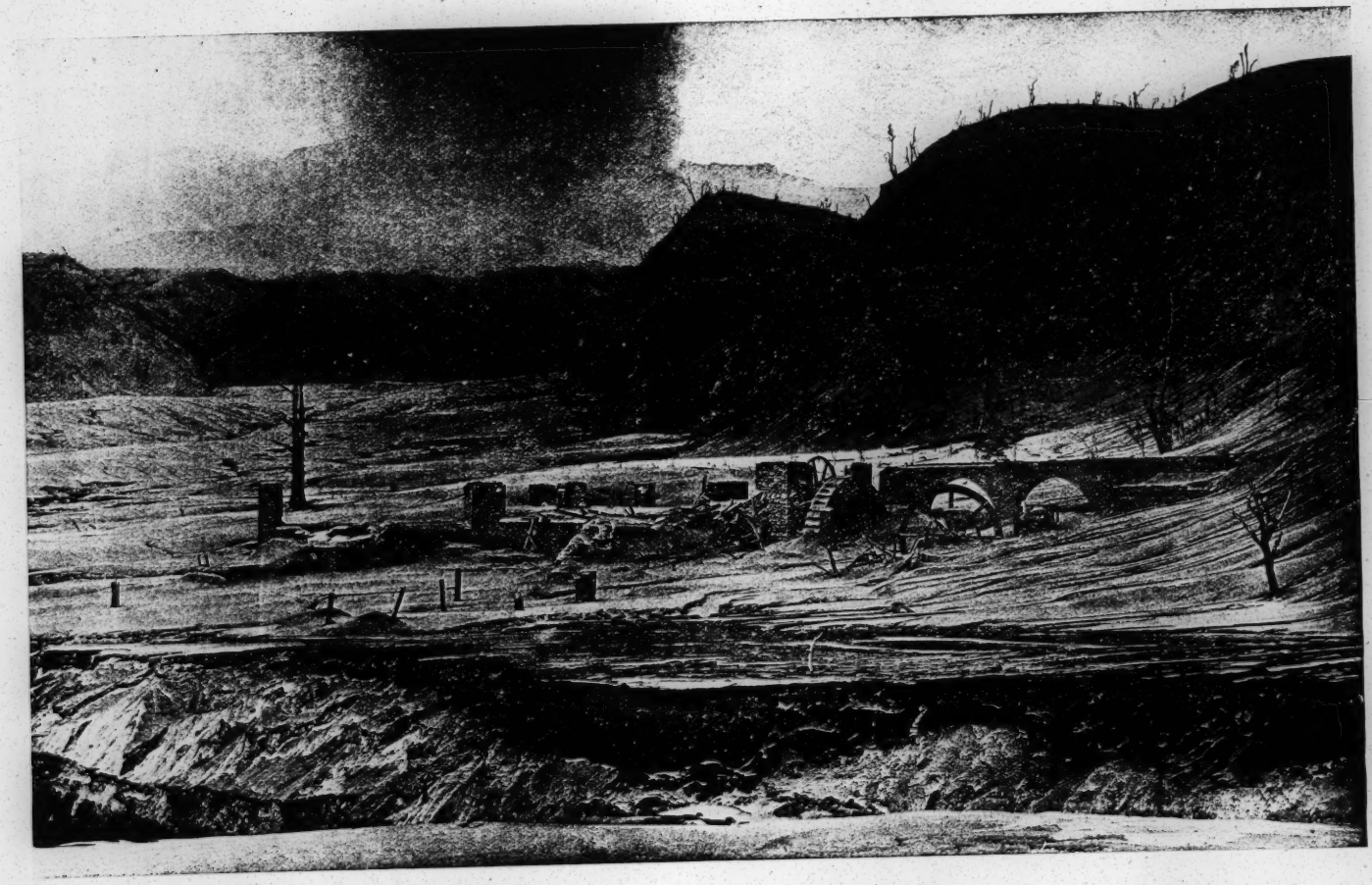
bombs answering this description have as yet been reported as occurring on Martinique or St Vincent. The nearest approach to a characteristic bomb are certain rudely spherical masses of lava with cracked surfaces and without projections or indications of a spiral twist. Evidently these poorly shaped bombs are composed of fresh lava which was sufficiently hot to make it somewhat plastic at the time it was blown into the air, but was too rigid to acquire the typical shape frequently to be seen in large numbers of bombs about certain basaltic craters.

The absence of characteristic bombs on Martinique and St Vincent is in keeping with the composition of the lava thrown out. The fresh lava is an andesite having in a general way the composition of a refractory brick, and unless very highly heated would not be plastic. The dark color of the columns of steam rolling up from the craters when in violent eruption and the vast quantities of fragmental material showered on the adjacent land and sea is evidence that as molten rock was forced up the volcanic conduits it became cooled and stiffened before reaching the summits of the volcanoes, and was shattered by steam explosions and the fragments blown into the air. Not only are true volcanic bombs absent, but clots and splashes of plastic or fluid rocks, such as are common about many volcanoes that have erupted easily fusible material, are also lacking.

The fragments ejected were in many instances blown to a height of many thousands of feet, the finer lapilli and dust being carried perhaps five or six miles high, and on falling were distributed in part through the influence of the winds, in a general way in reference to size and weight. The larger and heavier masses fell near the craters from which they were projected, while much of the finer and lighter material was carried great distances. Variations in the method of distribution were caused by the direction of the hurricane-like blasts which swept down from both Mont Pelée and La Soufrière during their mightier eruptions, by the direction of the trade winds and upper air currents, and by tornado-like swirls in the greatly disturbed atmosphere. The vastness of the area on which the ejected material fell is indicated by the fall of dust on Barbados, Trinidad, and on ships 275 miles southeast of St Vincent.

Observations reported by E. O. Hovey show that, contrary to earlier accounts, written in part by myself, coarse material fell in St Pierre. The riddling of boiler plates one-fourth inch thick, in the northern portion of the stricken city, by stone shot against them from Mont Pelée, is evidence that the hurricanes of steam charged with hot dust, which swept down from that volcano on May 8 or May 20, and perhaps during later eruptions, were accompanied by a bombardment of stones, no doubt hot, which were as deadly as solid shot fired from a cannon.

Causes of Death.—Respecting the general cause of death in St Pierre, the reports of various observers differ more widely than in connection with any



Ruins of the Wallibu Sugar Factory, St Vincent

Photograph by J. C. Wilson. Republished from the Bulletin of the American Museum of Natural History

other occurrence connected with the eruption of Mont Pelée, unless it be in reference to the secondary craters referred to above. Obviously many deaths occurred in St Pierre from the bombardment of missiles that swept through the city, as just mentioned, from the falling of walls and other objects, from the fire that followed the volcanic blast, from nervous shock, etc.; but opinions differ as to the principal cause of the loss of life. The opinions referred to fall in two groups: *a*, those favoring the idea that gases were the deadly agency, and, *b*, those which refer the loss of life to the effects of steam charged with hot dust.

a. Certain observers are strongly inclined to the opinion that Mont Pelée, or more accurately, the "Rivière Blanche subcrater," discharged gases which asphyxiated the inhabitants of St Pierre. As to the nature of the supposed gases, at least two suggestions have been made—one that it was mainly sulphureted hydrogen, and the other, carbon dioxide or some similar gas. Coupled with the first of these suggestions is the further hypothesis that gas explosions took place within the city and added to the deadly effect of the asphyxiating gases. The hypothesis that gases were the direct cause of the greater part of the loss of life, as claimed at St Pierre, has not, so far as I am aware, been extended to St Vincent, but the dead and the injured on the two islands met their fate in precisely similar ways. The evidence bearing on the question under consideration has been judiciously discussed by George Kennan, and the testimony of the sole survivor of the disaster of May 8 placed on record. Had noxious gases, and especially such heavy ones as carbon dioxide and sulphureted hydrogen, been swept over the city in sufficient quantities to kill nearly all the inhabitants, it is evident that the occupant of a cell below the level of the adjacent street would have been in a most dangerous position. The testimony of the prisoner referred to, as summarized by Kennan, after a critical cross-examination, is that he "heard no explosions or detonations; saw no flame; smelled no sulphurous gas; and had no feeling of suffocation. He was simply burned by hot air and hot ashes which came into his cell through the door grating."

It is impracticable to review in this essay all the evidence which it is claimed sustains the hypothesis of asphyxiation by gases. This side of the discussion, however, has been well presented by R. T. Hill in the NATIONAL GEOGRAPHIC MAGAZINE, in the *Century Magazine* and in *Collier's Weekly*, and by Angelo Heilprin in *McClure's Magazine* (see list at end of this essay).

b. The efficiency of steam charged with hot dust, or of either of these agencies alone, to cause scalds, burns, and even instantaneous death, is not open to doubt. The question is, Was the steam and hot dust swept over the portions of Martinique and St Vincent at the time so many thousand people were killed the chief agency in their destruction? Cumulative evidence has been added to the various classes of facts presented by me in the July number of this Magazine,* which sustains conclusions then reached. I refer to the narrative of George Kennan published in *The Outlook* for August 16; the preliminary report made by Tempest Anderson and J. S. Flett to the Royal Society of London, and the preliminary report made by E. O. Hovey to the American

*It was impracticable for me to read the proof of the article referred to, and in the titles of some of the illustrations, especially, there are serious errors. In the title of the plate opposite page 278, "Georgetown" should be substituted for "Kingstown;" the title of the plate opposite page 282, should be "Valley of Wallibu River deeply filled with hot débris;" on page 284, the title of the illustration should read "Summit of Morne d'Orange, St Pierre." The map on page 282 fails to show the area at the north end of St Vincent, as indicated on the original, which was not devastated, and is much generalized in other ways —I. C. R

Museum of Natural History. Although frankly confessing that I am not an unbiased judge of the printed testimony, yet it seems fair to claim that the evidence presented is conclusive as to the important part taken by steam and hot dust in the sudden destruction of the people of St Vincent on May 7 and of the inhabitants of St Pierre on May 8.

Downward Volcanic Blasts. — Intimately associated with the destruction of St Pierre is the direction taken by the blast of dust-charged steam, with its volleys of stones, which swept over the city. The hypothesis that St Pierre was destroyed by an eruption from the "Rivière Blanche subcrater" being rejected, and the further suggestion, based on the earlier reports in reference to the opening of a fissure in the side of the mountain, not finding support in later evidence, the way is cleared for a better understanding of the true cause of the direction taken by the down-blast that came, as now seems definitely proven, from the Étang Sec, which is essentially a summit crater.

To understand the nature of the volcanic blast which destroyed St Pierre, one needs to visit the region swept by a similar eruption on St Vincent. The volcanoes on these two islands have not only exhibited a direct relationship in the times of their eruptions, but the surface phenomena exhibited by one is the counterpart of what took place in the case of the other. Happily on St Vincent, however, there was no densely populated city within the radius of greatest destruction.

On St Vincent the region throughout which the previously luxuriant vegetation, plantations, etc., were swept away or buried beneath hot dust and stones encircles the mountain. The direction in which trees were swept down, and on the periphery of the devastated area the erosion of the bark of trees still standing on the side facing the volcano, as well as much other evidence, show in a most conclusive manner that a blast charged with dust and stones swept down the slopes of La Soufrière in all directions. The influence of hills at a distance of some four or five miles from the volcano in shielding the vegetation on their slopes facing away from it shows that the topography of the land controlled, in a measure, the direction taken by the volcanic winds. The presence of a partially encircling ridge or *summa*, on the northeast side of the volcano, seemingly accounts for the escape from destruction of a narrow fringe about the northeast border of the island. The outward direction that the blast took from the mountain, its decreasing intensity with increase in the distance it traveled, and the absence of even hypothetical subcraters, all bear witness that the heavily dust and stone charged steam from the old crater near the summit swept downward and outward with hurricane force, in a similar way to the more localized blast from Mont Pelée which destroyed St Pierre.

The one conspicuous feature of Mont Pelée which differs from anything on La Soufrière is the presence in the southwest portion of its active crater of a deep notch—the *Fente* or *Terre Fendue*—which, as stated by Heilprin, has been a conspicuous feature of the mountain since the eruption of 1851, and may have existed previous to that event. This cleft is in plain view from St Pierre, and during my visit to the dead city one could look into it and plainly see the ruddy cone of eruption with its ascending steam column that was being built within the crater. The area rendered desolate by the hot blast from Mont Pelée on May 8, and again swept over by a similar blast on May 20, is fan-shaped, the apex of the triangle being essentially at the summit of the mountain. The coincidence between the position and direction of the Fente and the apex of the expanding volcanic blasts may well be considered signifi-

Near Chateau Bellair, St Vincent, May 25, 1902

Steam rising after a shower, from hot débris in the valley of Wallibu River

Richmond Estate, St Vincent, May 25, 1902

Dunes of wind-drifted volcanic lapilli and dust from La Soufrière on a previously cultivated area. The tree trunks are the remains of palms. The rill channels show the beginning of the erosion of the freshly added layer, which is from three to ten or more feet thick (see page 432)

cant. From the various accounts of the eruptions of Mont Pelée available, it now seems evident that the blasts which destroyed so much of the vegetation of Martinique and wrought havoc in St Pierre came from the crater with a deeply notched rim, and that the direction taken by the blasts, at least on May 8 and May 20, was determined by that rift in the crater's rim.

As stated by T. A. Jaggar, the downward blasts from volcanoes do not require a horizontal nozzle to project them. "They are simply the result of the down-blast after the heavy gravel has begun to fall, acting against the upblast from the throat of the volcano, and both together deflected and thrown into terrific whirls or tornadoes." This explanation, although briefly stated, may seemingly be taken as the leading cause of the downward sweep of the steam charged with rock fragments on both Mont Pelée and La Soufrière. It does not seem clear, however, that the down-blasts occur only after a towering column of débris-charged steam has reached a great height and the fall of the heavier material within it has begun. Then, again, it may be asked why it is that every strong eruption is not followed by a down-blast?

Variations in the character of volcanic eruptions of the type under consideration occur on account of variations in the energy of the explosions and the

degree to which the ascending steam is débris-charged. If the energy is great and the upward propelling force essentially constant, it may well be inferred that the column, as explained by Jaggar, will attain a great height before the resistance it offers to the ascent of fresh material causes an expansion at the base. If, however, the steam driven out at any stage in an eruption is excessively loaded with débris, an expansion and overflow at the rim of a crater might occur, no matter whether the fall of previously discharged material from aloft had begun or not. The essential feature in a down-blast from a crater seems to be that heavily débris-charged steam behaves in many ways like a fluid and will flow down steep gradients and acquire great velocity when the slope and other features of the surface over which it progresses are favorable. The gradients on the slopes of Mont Pelée and La Soufrière, within the zone of destruction in each case, are about 1,000 feet to a mile, and, as seems evident, the finally accepted explanation as to the controlling condition which gave direction to the blasts which swept them will include the principle just stated. In this connection it is instructive to note certain observations made by Messrs Anderson and Flett, commissioners sent by the Royal Society of London to study the recent eruptions. On the evening of July 9 these gentlemen were on a vessel near Carbet and witnessed an eruption of Mont Pelée.

"As the darkness deepened, a dull-red reflection was seen in the trade-wind cloud which covered the mountain summit. This became brighter and brighter and soon we saw red-hot stones projected from the crater, bowling down the mountain slopes and giving off glowing sparks. Suddenly the cloud was brightly illuminated, and the sailors cried, 'The mountain bursts!' In an incredibly short space of time a red-hot avalanche swept down to the sea. We could not see the summit owing to the intervening veil of cloud; but the fissure and the lower parts of the mountain were clear, and the glowing cataract poured over them right down to the shore of the bay. It was dull red, with a billowy surface, reminding one of a snow avalanche. In it there were large stones, which stood out as streaks of bright red, tumbling down and emitting showers of sparks. In a few minutes it was over. A low, angry growl had burst from the mountain when this avalanche was launched from the crater." The time occupied by the avalanche to reach the sea was "possibly a couple of minutes. It could not have been much more." . . .

"There is no doubt that the eruption we witnessed was a counterpart of that which destroyed St Pierre. . . . The most peculiar feature of these eruptions is the avalanche of incandescent sand and the great black cloud which accompanies it. The preliminary stages of the eruption, which may occupy a few days or only a few hours, consist of outbursts of steam, fine dust, and stones, and the discharge of the crater lakes or torrents of water or of mud. In them there is nothing unusual, but as soon as the throat of the crater is reached, a mass of incandescent lava rises and rolls over the lip of the crater in the form of an avalanche of red-hot dust. It is a lava blown to pieces by the expansion of the gases it contains. It rushes down the slopes of the hill, carrying with it a terrific blast, which mows down everything in its path. The mixture of dust and gases behaves in many ways like a fluid. The exact chemical composition of these gases remains unsettled. They apparently consist principally of steam and sulphurous acid." . . .

The account just quoted of a typical down-blast from a volcano, seen under favorable conditions by trained observers, is perhaps the best evidence on rec-

ord from which to judge of the nature of certain phases of several of the recent eruptions. In the instance cited, there does not seem to have been a lofty column of dust-charged steam standing above the summit of the mountain, which deflected the upward blast from the vertical conduit of the volcano, but, owing to the density of the mixture of steam and dust driven out, it overflowed the lip of the crater and rolled down the mountain side. That is, one condition, as previously stated, which may bring about a marked variation in the nature of an eruption, and in fact furnish the chief control of the secondary phenomena, is the density with which the steam extruded is charged with solid matter. This condition may obtain control even when the explosive violence is not enough to drive the dust-laden steam to a great height. The degree of comminution would no doubt be another factor influencing the result. The finer the solid material was comminuted, the more fluid-like would be the mixture.

In an eruption like that described above the topography may exert a decided influence. During eruptions of great but of not the maximum intensity the deep notch in the southwest portion of the rim of the active crater of Mont Pelée would give direction to the escaping dust-charged steam and determine the course the expanding avalanche would take. In the absence of such a notch, as in the case of La Soufrière, the overflow would be radial. A more intense eruption from Mont Pelée might also be radial, the notch in its rim failing to influence so completely the direction taken by the greater discharge. This is what seems to have occurred during the later eruptions of the volcano, when Morne Rouge and other villages were destroyed.

Mud Flows.—The valleys on the lower slopes of both Mont Pelée and La Soufrière have in numerous instances been filled to a depth of 40 to 60 or more feet with hot dust and stones. The streams have thus been displaced, and are striving to regain their right of way, but as yet, owing largely to the washing down of dust, lapilli, etc., from bordering slopes, are making but slow progress with their work. In many instances, in fact, the high-grade rills are bringing to the main drainage channels more débris than the master streams can remove, and the process of valley-filling continues. Water finding its way into these beds of hot débris, as already mentioned, causes steam explosions, sometimes of such energy as to resemble a primary eruption from one of the main or true craters. These eruptions at times hurl large quantities of débris into the stream channels which have been partially cleared, thus producing dams and causing small lakes to form. These water bodies rise until they overflow the accumulation of loose material restraining them, when they are rapidly drained, and floods of water heavily charged with débris occur below where the temporary dams were formed. The mud flows originating in these and other similar ways have been frequent on both Martinique and St Vincent, and have in several instances been referred to as lava flows.

Erosion.—Much that is highly instructive centers about the manner in which the surface waters are removing the freshly added material from the surfaces of Martinique and St Vincent. Instead of being a protection to the surface on which it rests, the fresh débris is in many instances of assistance in its more rapid erosion. On steep slopes and even when the surface is nearly level, the rills formed during the numerous tropical showers quickly cut through the loose surface material and, aided by the angular particles in suspension, corrode the soil or rocks beneath. The rains, as it seems, are heavier than usual, owing to two causes: First, the

great amount of water contributed to the atmosphere as steam, and, second, the vast amount of dust blown into the air, each particle of which serves as a center for condensation. The process of fashioning the topography throughout the extensive areas from which all vegetation has been removed is greatly accelerated. This more rapid erosion will, no doubt, continue until the surface is again plant-clothed.

The volcanic eruptions have claimed so much immediate consideration from the several geologists and geographers who have visited the stricken islands that the indirect geographical changes resulting from them have not received the attention they deserve. Not only the pulsating streams of steaming water and their occasional great discharges of hot mud demand detailed study, but the way in which the undermining of banks of loose débris leads to landslides, the development of consequent and subsequent streams, the manner in which streams develop and rapidly pass from youth to old age, etc., deserve to be carefully recorded. The streams are not only eroding but depositing. Deltas are being formed and additions made to the land. The final resting places of the fresh débris which fell on the islands will be in the adjacent sea, where great quantities of fragmental volcanic material is being spread out to form stratified tuffs.

Waves in the Sea.—Reports have appeared in the newspapers, from time to time since early in May, of so-called tidal waves. As is well known, the waves referred to have no connection with the tides, but are similar to those occasionally accompanying earthquakes. So far as can be judged, however, the unusual waves that have recently broken on the shores of Martinique and St Vincent have not been due to movements in the earth's crust, such as commonly produce earthquakes, although some of them may have been of that nature. The waves referred to have been caused, in most instances, by the disturbances produced in the water of the sea by the blasts of dust-laden steam that have swept down from the craters of Mont Pelée and La Soufrière. Similar waves have also been generated by the entrance into the sea of stupendous mud flows, or, perhaps more properly, avalanches of rock débris and water, like the one which destroyed the Guerin sugar factory on May 5. Again, landslides have occurred in the loose deposits on the Caribbean shores of both Martinique and St Vincent, and similar slides, as indicated by the breaking of telegraph cables, have probably taken place on the steep submerged slopes of the mountains whose summits form the islands mentioned. In these several ways, waves in the sea appear to have been generated, but in all instances they have been low and but little damage from them has resulted. The earthquake shocks that accompanied the recent eruptions have been comparatively light, and, so far as can be judged, not of such a nature as to cause large waves in the adjacent sea. The earthquake shocks, however, may and probably did bring about the descent of some of the landslides on the margin of the sea and on the steep submerged slopes, and in this way are indirectly accountable for some of the sea waves.

Landslides.—The landslides just referred to occurred principally on the west side of St Vincent, to the north of Chateaubelair, where strips of nearly flat alluvial land, adjacent to the sea, have disappeared, leaving fresh bluffs of loose débris some thirty or forty feet high. It has been suggested that this disappearance of land, and in one instance of the site of a village, was due to movement along a fault—that is, the subsidence of the rocks on one side of a deep fracture in the earth's crust—but the evidence does not seem to sustain this hypothesis. The lands that have disappeared, as shown by the es-

carpments remaining, were composed of unconsolidated débris, deposited for the most part directly by streams as deltas. This loose material, resting on the steeply inclined rocks beneath, was in a position to be easily dislodged by earthquake shocks, by the rush of mud avalanches down the valley, at the mouths of which the deposits had been made, and by the return waves when the sea was disturbed by the volcanic blasts or by mud avalanches. The changes made by subsidence of the land are not great, and, as several observers have stated, may reasonably be accounted for in the manner just referred to.

Electrical Displays.—The graphic accounts that have been published of the recent eruption give a better idea of the magnificence of the electrical phenomena accompanying volcanic explosions than was previously attainable. These observations show that an interesting and difficult problem here awaits solution. The most striking phase of what is assumed to have been an electrical display during a primary eruption of Mont Pelée on the evening of May 26 is thus described by George Kennan:

"The feature of the eruption that made the deepest impression upon me was the stellar lightning. The uprush of black smoke, the glow over the crater, and the shower of incandescent stones and cinders were all phenomena that had been observed and described before; but the short, thin streaks of lightning, followed by star-like explosions in the volcanic mantle—not only above the crater, but miles away from it—were entirely new. The distinctive characteristics of this lightning were the shortness of the streak, the comparatively great size and brilliancy of the spark, or light-burst, at the end of the streak, and the single booming report that followed. Sometimes three or four great sparks, connected by fiery streaks, would flash together in this way; and at other times the stars would burst so far back in the cloud that the streaks were invisible and there was only a circular irradiation of the vapor. If there was any storm lightning, of the ordinary kind, in the earlier stages of the eruption, it was so much less noticeable than the stellar lightning that it escaped my observation; and I am quite sure that there was no rolling, reverberating thunder at all until near the close of the display, when reddish lightning-bolts began to dart down on the volcano from the developing storm-cloud over the crater. Before that time all, or nearly all, of the electric discharges had ended in stellar light-bursts, and all of the thunder had been made up of separate and distinct reports, like the thunder of a heavy and rapid cannonade."

In reading this account one can scarcely avoid making the tentative suggestion that the streaks of light and brilliant explosions, apparently resembling the trails and occasional bursting caused by meteoric bodies entering the earth's atmosphere, may have been due to intensely heated solid particles on entering the oxygen-charged air.

Other Phenomena.—A final report on the recent and still continuing eruptions of Mont Pelée and La Soufrière must include the evidence in reference to: the sounds generated, the earthquake shocks, the areas on which dust fell and its relation to the direction and force of air currents, gravity waves in the air, influence of dust in the air on sunlight, and, most interesting of all as well as the most novel, the magnetic waves generated, some of which were recorded almost instantaneously at several magnetic stations in the United States and Canada.

The Study of the Earth's Interior.—Perhaps the chief lesson taught by the recent volcanic eruptions in the Antilles is the meagerness of our knowledge

concerning the interior of the earth. In this more pointedly, perhaps, than in related fields is the saying true that "the known is but a small fraction of the unknown." In the study of the earth's interior, the search for the ultimate causes of volcanic eruptions, etc., a visit to an active volcano is most instructive and suggestive, but such investigations should not end with the cessation of the outbreaks.

The manifestations which reach the earth's surface and on which our judgment as to the condition of its interior must be chiefly based are movements in the rocks, earthquakes, escape of heat, magnetic changes, etc. While several of the phenomena referred to become especially prominent during volcanic eruptions, they are not confined to such occurrences or to the vicinity of volcanic vents, but may be studied at all times and at any locality. Among the records which it is desirable to obtain and from which some judgment in reference to the condition of the earth's interior may be had are the occurrence of earthquakes, their character, direction of motion, location, both geographical and vertical, of their centers and all else concerning them, and changes in the magnetic condition of the earth. Observations in these directions are highly desirable in the vicinity of volcanoes in order that they may serve as danger signals, but may yield valuable returns when carried on at a distance from all centers of volcanic disturbance.

In this connection I wish to suggest that the National Geographic Society can make a substantial addition to our knowledge of the earth by maintaining a magnetic and seismographic observatory. Let a start be made by placing in our Hubbard Memorial Building the best instruments of the nature just referred to that can be had, and extend assistance to individuals, colleges, etc., at as many other localities as practicable, in establishing similar observatories.

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THE COPYRIGHT OF A MAP OR CHART

By William Alexander Miller,

Author of "Copyright Protection for Photographs"

WHEN our forefathers were assembled in the second session of the First Congress on the last day of May, 1790, and decided to pass a copyright law, the first article that they mentioned to be protected was a "map." Then in that act followed the words "chart, book, or books."

You think how good a life you will lead, and you map out great purposes.—*Ike Marvel, Dream Life.*

By giving maps the preference, first mention in the law, now seems but to emphasize the fact of the greatest need of the country at that time in such productions. There was a dearth of maps, and prior to the passage of the statute mentioned positively no encouragement to draftsmen and cartographers. The science of chartology was almost unknown and but little practiced in America previous to the advent of the copyright law. What meager accomplishments there were in those lines were generally performed by foreigners. Our country was at sea, without a chart. There had been much plotting against the British, but scarcely none in the making of maps.

Undoubtedly, Miletus was the birthplace of cartography.—*Von Ranke.*

Every ship that comes to America got its chart from Columbus.—*Emerson.*

The law of 1790 was the first of our copyright acts, and secured protection to authors and proprietors for their productions for a period of fourteen years, with an extension for fourteen more. Thus the longest possible term of a copyright was twenty-eight years (a term copied from the provisions of the old English law). Our law-makers have since very wisely extended the life of a copyright, so that now the original is granted for a period of twenty-eight years and with provisions for a renewal for fourteen years additional.

Language has been called a map of the science and manners of the people who speak it.—*Max Müller.*

> It is among the Egyptians that we find the earliest recorded examples of cartographic representation. Apollonius of Rhodes (b. 230 B. C.) reports in his Argonautica that the Egyptians of Colchis, a colony dating from the time of Rameses II, had preserved as heirlooms certain wooden tablets on which land and sea, roads and highways, were accurately indicated.—*Encyclopædia Britannica.*

BENEFICENT EFFECT OF THE LAW

The results expected to be attained by the framers of our law for the encouragement of map-makers have been far beyond any of their reasonable anticipations, until at the present time the United States of America is leading the world in the productions of this wonderful art, one so useful to mankind. The quality of our product is of the very finest.

Thus in his cheek the map of days outworn. — *Shakespeare.*

The government itself, by reason of its great consumption of maps, has been a leading factor in raising the standard and in educating and encouraging the map artist—or should we say the map scientist? Geneva, Switzerland, said to have been for so many years the greatest map-producing center of the world, has been relieved of the laurels she so gracefully wore, and our own Washington carries the honor as one of the pearls in her precious diadem. A dozen different bureaus of our government are engaged in map-work of some sort, not alone of this country, but of all portions of the globe, its seas and skies. It has enticed to our shores the best workmen of Europe.

Not such maps as you wash houses with, but maps of countries. — *Middleton, Spanish Gypsy.*

Government maps are public property, so far as the copyright provisions are concerned, and are not copyrightable. This is one of the reasons why private establishments are enabled to issue more and better maps of many kinds at a low price than can be turned out anywhere else on the globe. It is getting so now that when one wishes to make a journey afoot or by train, carriage, wheel, or automobile a map can be consulted for information as to roads, time, distances, grades, bridges, paths, hostleries, repairs, and fuel, to make no mention of the weather and stars and tides. The practical benefits are multifarious.

Peering in maps for ports and piers and roads. — *Merchant of Venice.*

> When Hecataeus (500 B. C.) warned his countrymen against engaging in a conflict with Darius he enforced his arguments by pointing out the vast extent of the Persian Empire upon a map of the "entire circuit of the world," which had been engraved upon a brazen tablet.—*Mill's International Geography.*

DIRECTIONS FOR OBTAINING COPYRIGHT

It is the design of the writer in this article to give a few simple, elementary directions for the guidance of the applicant for copyright protection. When a map or chart has been produced and the author or legal owner of it desires to obtain the benefit of the copyright privileges, the first step should be to write to the Register of Copyrights, Washington, D. C., for a blank application. These blanks are so arranged that in a few words the applicant can insert all necessary information. The use of the blank will insure the quickest possible favorable action, and any other form of application is liable to omit some vital requirement of the law, causing delay and perhaps vexation. The prime requisites are: Name and address of the applicant; amount of money enclosed and its nature; nature of the article to be copyrighted; title of the work; name of the claimant of the copyright and residence; country in which the article is to be printed or produced; name of the author and of the country of which he is a citizen or subject; form of claim, as to whether author, designer, or proprietor; name and address to whom reply is to be mailed; a copy of the printed title.

After the blank has been received and filled out, there will be noticed that

there is a space on the third page for attaching the title of the map. For this purpose the corner of the map which contains the title and the usual copyright notice as it will appear when issued to the public should be cut off and attached to the blank by pasting. This should all be attended to before the day of publication. If possible it is well to send the application, the fee, and the two complete copies required to be deposited, all in one package, to the Register of Copyrights. The results will be quicker and surer.

As to the matter of fees: For each title the fee is 50 cents, provided the author is a citizen of the United States, but if he be a citizen of a foreign country with which this country has copyright relations the fee is $1. If a certificate is desired (which shows how the entry will appear on the records) an additional fee of 50 cents will be necessary. Maps published in two sizes, that is where the scales of the two differ, require two separate entries and fees for copyright. A postal money order is the best form for remitting fees, and it should be made payable to the Register of Copyrights.

If the article to be copyrighted is a map, it should not be alluded to by any other name. The statement should be plainly made that it is a MAP. It should not be designated a chart, plat, plot, or atlas; an atlas is a book of maps. The applicant must bear in mind the fact that the law contemplates a map as being a delineation of some portion of the earth's surface. Not everything popularly so called is a chart in the meaning of the law.

I am near to the place where they should meet, if Pisanio have mapped it truly.—*Cymbeline.*

If one wishes to protect a chart much care should be exercised, owing to the different meanings given to that term by the public, the dictionaries, and the law. The application should read: "A MAP OR CHART." The law regards a "chart" as a special kind of map, as a delineation of some portion of the heavens or of the waters of the earth, more plainly as a map of stars or a map of waters. Neither is it a plan or drawing of other objects or a card or sheet showing tabulated information. The public is prone to characterize a variety of things as charts, and when they get before the copyright officials meet with disappointment in many instances. As early as 1828 a decision was handed down stating that a copyright cannot subsist in a chart as a general subject (Blunt *vs.* Patten, Fed. Cas. 1580; 2 Paine, 397). If an applicant have a drawing, pattern or chart, as it is commonly called, to be used on a cutting machine and with directions for its use, he cannot obtain a copyright as a "chart," but would have to apply for protection as a "book." In the case of Drury *vs.* Ewing (Fed. Cas. 4095; 1 Bond, 540) the court decided that a chart on a single sheet, containing diagrams representing a system of taking measures for and cutting women's dresses, with instructions for its use, is a "book," within the copyright law. Another has a music staff and scale which he terms a "musical chart." The law knows of no such "chart," and the only possible chance for the applicant might be in apply-

We map the starry sky.—*M. Arnold.*

ing as a "book." Then there is "A Chart of the Greater United States—An Up-to-Date Historical, Political and Statistical Record, with Maps, Etc." That would be a "book" pure and simple and should be applied for as such. Another phase of the meaning of the word "chart" will be seen in the decision of the court in the case of Taylor *vs.* Gilman (24 Fed., 632), in which it was held that the word "chart" as used in the copyright law does not include sheets of paper exhibiting tabulated or methodically arranged information, but such articles might be protected as books.

The law requires that on or before the day of publication two copies of the completed map or chart shall be deposited with the Librarian of Congress. In the case of a map or chart, unlike that of a book, photograph, chromo, or lithograph, the two copies to be deposited need not be made in the United States. It would seem that the day has now arrived when the provision should be inserted in our law requiring the copyrighted maps and charts to be engraved and printed in this country. There is a provision in the statutes for the granting of copyright on new editions wherein substantial changes shall be made. In such case it is necessary either to make out a new application, as in the first instance, and send it, with the proper fee, to the Register of Copyrights, and on or before the day of publication forward two copies of the article for deposit; or, merely deposit one copy of every such edition without making a new application. It is perhaps better to file a new title, describing the map or chart as being the second or third or some other edition, revised, etc. In 1872, in the case of Farmer *vs.* Calvert Lithographing Company, the court held that new editions of maps are included in the copyright laws (Fed. Cas. 4651; 1 Flip., 228).

> The scientific treatment of geography and map-making has its origin among the Ionic Greeks of Asia Minor. Anaximander, a pupil of Thales (about 560 B. C.), sketched the first map and was the first who sought to determine the compass of the earth (the world disk) and the sea.—*Encyclopædia Britannica.*

HISTORY OF THE DEPOSIT OF COPIES

The matter of the deposit of the copies has had quite a little variety in its history. The original copyright law required that but one copy of the map should be deposited with the Secretary of State within six months after the day of publication. In the first general revision of the copyright laws, which occurred in 1831, it was stipulated that one copy of the article protected should be deposited within three months after publication with the clerk of the court who recorded the title, and this copy was to be sent by the clerk of the court to the Secretary of State. That was during the days when copyright applications were made to the circuit courts of the United States instead of to the Register of Copyrights, as at the present time.

> There was no other pastime nor exercise among the youth but to draw plattes of Sicile and describe the situation of Libya and Carthage. — *Plutarch.*

On the establishment of the Smithsonian Institution by the act of August 10, 1846, the above provision as to the deposit of copies was changed, requiring the delivery within three months from publication of one copy to the Librarian of the Smithsonian Institution and one copy to the Librarian of Congress. In the Post-Office Department appropriation bill for the fiscal year 1856 (passed March 3, 1855) free transportation through the mails was provided for copyright deposits. In an act providing for keeping and distributing public documents, passed February 5, 1859, it was declared that the copyright deposits and records should be removed from the Department of State to the Department of the Interior. By the act of February 18, 1867, a penalty of $25 was imposed for failure to deposit copies in the Library of Congress.

In the second revision of the copyright laws (act of July 8, 1870) all records and other things relating to copyrights, including the deposits of books, maps, etc., in the Department of the Interior, were transferred to the Library of Congress. The Librarian was required to give an additional bond of $5,000, and his salary was increased to $4,000. By this law two copies of the best edition of any article copyrighted was to be deposited within ten days after publication in the Library of Congress and one copy of any subsequent edition. The provisions of the law now in force regarding the deposit of copies have been already given above.

Of the two copies of each map or chart deposited in the Library of Congress one is retained in the files of the Copyright Office and the other is placed in the Division of Maps and Charts. The map room of the Library is one of the most interesting portions of that great building and is liberally patronized by cartographers, scientists, and students generally.

In another roome are represented at large mapps and plotts of most countries in the world.—*Evelyn, 1645.*

Marinus of Tyre (about 150 A. D.) was the first who sought to give effect to the demands made by Hipparchus for a trustworthy representation of the countries of the world.—*Encyclopædia Britannica.*

THE COPYRIGHT NOTICE

In obtaining a copyright on a map or chart there are three steps to be taken: (1) Deposit of printed title; (2) Deposit of two complete copies; (3) Insertion of the proper notice of copyright. The first two steps have been discussed, and now we come to the last one of the three. When one critically examines the notices as published, in the great majority of cases they are illegal, inasmuch as they do not follow the form prescribed by the statutes. In the original law a copy of the record was to be published in one or more newspapers of the United States for four weeks. No other notice was required.

By the act of 1802 it was required to be inserted at full length a copy of the record on the title page or page following in case of a book, but if map or

chart should cause the following words to be impressed on the face thereof: "Entered according to the act of Congress, the — day of ——, 18—, by A. B., of the State of ——." This in addition to the publication in the newspaper as before. By the act of February 3, 1831, the notice was changed to read: "Entered according to act of Congress in the year —, by A. B., in the clerk's office of the District Court of ——."

When the Librarian of Congress assumed control of the copyright affairs by virtue of the act of July 8, 1870, the notice was changed to: "Entered according to act of Congress, in the year ——, by A. B., in the office of the Librarian of Congress, at Washington." The latter version was reënacted in the revision of the copyright laws in 1873 (December 1), but by the act of June 18, 1874, it was made optional as to whether one used that notice or "Copyright, 18—, by A. B," the latter being the briefest and best, covering all essentials. At the present time the applicant has the choice of the two forms, though the cumbrous old methods are nearly obsolete and the shorter one has come into almost universal use. The trouble in many cases is that either the date or the name of the proprietor of the copyright is omitted.

It will be seen that there are three things necessary in the notice: (1) Statement of copyright; (2) year in which printed title was deposited; (3) name of the proprietor of the copyright. To emphasize the necessity of giving proper attention to the notice it will be well to here cite the decision in the case of King *vs.* Force, in which the court held that "the omission to have the date of depositing the title of the map engraved thereon is fatal to the plaintiff's title to a copyright (King *vs.* Force, 2 Cranch, C. C., 208). That was as early as 1820. Error in the mention of the date in the copyright notice may be attended by serious consequences or it may be practically immaterial. In the case of Callahan *vs.* Myers the court said: "The title having been deposited in 1867 it is immaterial as to third persons that the notice printed in the work states that the copyright was entered in 1866." Here the error would result simply in shortening the period of copyright protection one year, which in most cases would not be considered a matter of consequence. But if the error was the other way, that is, if the year mentioned in the copyright notice was subsequent to the year of copyright entry, the consequences would be most serious, for in a case where the title page of a book was deposited in 1846 and the notice of the entry as printed in the copies of the book stated the entry to have been made in 1847, the court held that the error, whether arising from mistake or not, was fatal (Baker *vs.* Taylor, 2 Blatch., 82).

> The Romans contributed nothing to the development of the scientific methods of the Greeks, and did not apply astronomy to the purposes of cartography. They valued maps according to their practical utility as implements of political administration; and they accordingly attached most importance to the route-map, from which they could learn the roads and the distances.—*Encyclopædia Britannica.*

OTHER LEGAL DECISIONS

A survey of a shoal made by plaintiff at his own expense, and used as the basis of a map copyrighted by him, does not become a public document by being deposited in the Navy Department for the use of the government, so that a third person may also use it as the basis of a map (Blunt *vs.* Patten, Fed. Cas. 1579; 2 Paine, 393).

Copyright, being an incorporeal personal right, is not liable to be seized by sheriff in execution, etc. Even when one has obtained a copper-plate under an execution he is not thereby entitled to print and publish copyrighted matter therefrom (Stephens *vs.* Cady, 55 U. S., 14 How., 528; 14 L. Ed., 528; Fed. Cas. 13400; Stevens *vs.* Gladding, 58 U. S., 17 How., 447; 15 L. Ed., 155). The profits, however, may be reached by a creditors' bill.

The right of an author or of a proprietor under the copyright law is infringed only when other persons produce a substantial copy of the whole or of a material part of the book or other thing for which he secured a copyright; but any one by his own labor, etc., may make a new map, and where, therefore, the owner of a copyright for maps of certain wards of the "city of New York, surveyed under the direction of insurance companies of said city, which exhibit each lot and building, and the classes as shown by the different coloring and characters set forth in the reference," brought his bill to restrain the publication of similar maps of the city of Philadelphia, the court held that the bill could not be sustained (Perris *vs.* Hexamer, 99 U. S., 674; 25 L. Ed., 308). To maintain an action the complainant must show that his map has been copied.

The statement has been made that occasionally some map-makers intentionally introduce slight errors in order to more effectually catch the unwary infringer. Appearance of such an intentional error has been held evidence of copying. From the identity of the inaccuracies, it is impossible to deny that the one was copied from the other *verbatim et literatim* (Longman *vs.* Winchester, 16 Ves., 269. See also Murray *vs.* Bogue, 1 Drew, 366, and Lawrence *vs.* Dana, 2 Am. L. T. R., N. S., 402). The penalty for the infringement of a copyrighted map is $1 for each copy found in the possession of the infringer, provided that the sum to be recovered in any one action shall not exceed $5,000. The plaintiff can also demand an accounting of the profits and obtain an injunction to prohibit further infringement.

I see, as in a map, the end of all.—*Richard III.*

What ails us, who are sound,
That we should mimic this raw fool, the world,
Which charts us all in its coarse blacks and whites?
—*Tennyson.*

THE ERUPTIONS OF LA SOUFRIÈRE, ST VINCENT, IN MAY, 1902*

By Edmund Otis Hovey

THE surface rocks of the island of St Vincent are wholly of direct volcanic origin, with the exception of some elevated beach conglomerates occurring along the windward (eastern) coast. These conglomerates, too, are composed of boulders and gravel of volcanic origin derived from the island itself. These conglomerates, water-worn sea benches at three altitudes, elevated sea caves, and the evidence of an old shore line northwest of Georgetown are indications of an elevation of the island of about 200 feet during recent geologic time. The southern portion of the island is the oldest, as is evidenced by its stage of erosion, which is much farther advanced than that of the northern part. Broad valleys, with bottoms of comparatively gentle slope, are to be found about Kingstown, Calliaqua, Mariaqua, Mesopotamia, and elsewhere in the south, while the northern half of the island is remarkable for the extremely rugged character of its topography.

Volcanic activity on St Vincent has moved from south to north, as it has on Martinique, St Kitts, and some of the other Caribbean Islands, but it has long centered about the present active crater, La Soufrière. Numerous lava beds alternate with the, apparently, far more extensive beds of tuff agglomerate in the make-up of the island. Tremendous eruptions of the explosive kind, like the present one, though on a far larger scale, have been frequent occurrences in the geologic history of the island. According to Hill,† the volcanic Caribbean Islands date from at least as far back as Eocene time, but eruptions have been very rare within historic time, which extends over four centuries. The heaviest recorded eruptions have been those of La Soufrière, which took place in 1718 and in May, 1812. The latter is said to have formed the "New" crater, 500 feet in diameter, on the northeast side of and higher than the much larger "Old" crater. The Old crater was about nine-tenths of a mile long from east to west and about eight-tenths of a mile wide from north to south, according to the British Admiralty chart, and was famous

*The author was sent to Martinique and St Vincent by the trustees of the American Museum of Natural History, New York, as the representative of that institution, to study the phenomena in connection with the eruptions of the present year. I was a passenger with the delegates of the National Geographic Society on the United States cruiser *Dixie* on her memorable voyage for the relief of the impoverished inhabitants of the devastated islands, and I indorse most heartily the praise given by I. C. Russell and R. T. Hill, in their reports to the Society, to Capt. R. M. Berry, U. S. N., commanding the *Dixie*, and to the other officers of the cruiser for their hospitality and their kindness to the scientists.

On St Vincent our work was greatly facilitated by the intelligent activity of F. W. Griffith, government clerk, acting under general instructions from Sir Robert Llewellyn, C. M. G., governor of the colony, and by the assistance rendered by T. MacGregor MacDonald, a planter owning several estates on the leeward (west) side of the island. James E. Richards, a merchant of Kingstown, placed at the disposal of my colleagues (Dr. T. A. Jaggar, Jr., and George Carroll Curtis) and myself his cottage at Petit Bordel, near Chateaubelair on the leeward coast, from which there was an unobstructed view of the volcano. The facts embraced within this article have been embodied, together with the author's observations on Mont Pelée, in a "Preliminary Report," presented to the trustees of the American Museum of Natural History, and published in the "Bulletin" of the Museum, vol. xvi, pp. 333–372, pls. xxxiii–li.

†This Magazine, vol. xiii, p. 229, July, 1902.

for the beautiful lake within it, the surface of which was 1,930 feet above tide, or about eleven hundred feet below the southern rim of the crater. The depth of this lake in the center was 87½ fathoms, according to the statement of P. F. Huggins, engineer, of Kingstown, who told me that he sounded it in 1896 (see table in appendix). The northwestern portion was deeper, but Mr Huggins's line was too short to reach bottom there. The walls of the crater were precipitous, like those of Mount Misery, on the Island of St Kitts, and others, while the outer slopes of the mountain were comparatively gentle, except as they were deeply cut into by the very steep-sided ravines of erosion.

It is difficult for one who has not visited the Lesser Antilles to realize the precipitous character of the ravines cut into the old tuff beds by the mountain torrents. Slopes of 65° and 75° are common, while those of 85° and verticality are not rare. Under the usually prevailing conditions, every slope is covered with such dense vegetation that its true character is not perceived at once, but the denudation on St Vincent and Martinique resulting from the terrible blasts occurring during the eruptions of this year has revealed in a striking manner the wonderfully rugged topography of the northern parts of the islands.

In April, 1901, earthquakes began to be noticeably more frequent than usual at Kingstown, suggesting to F. W. Griffith, of that place, the idea that trouble might be expected from La Soufrière, as had happened ninety years before, according to the diary of his grandfather, who was living at Kingstown at the time. Mr Griffith's prophecy received little attention, but by December of last year La Soufrière itself was rumbling to such a degree that the people living on the Windsor Forest and other estates on the northwestern and western slopes of the mountain became greatly alarmed, and could with difficulty be persuaded to remain at their homes. During the succeeding weeks the rumblings became less violent, only to return with renewed force in February.

The warnings of an approaching eruption became so unmistakable by the end of April and the beginning of May that nearly every one had left the doomed leeward district north of Chateaubelair by the 6th of the latter month. On the windward side conditions were different, and but little alarm seems to have been felt. The earthquakes were not as severe and it was supposed that, in case of any eruption, the trade winds would carry all ejecta toward the west. A deceptive security! When the great outburst took place, at 2 p. m., May 7, but one person was killed on the leeward side of the island, while on the windward side about thirteen hundred and fifty persons were killed outright during the eruption or died afterward of injuries received then. Thousands of families in the northern half of St Vincent were rendered homeless and destitute by the storm of lapilli (volcanic dust and ashes), which in a few minutes swept every vestige of tropical verdure from about one-third of the island, replacing the beautiful variegated green of the slopes with a uniform dull gray—the token of desolation.

Mr MacDonald,* from his estate at

*Mr MacDonald's notes were published in full in the Kingstown *Sentry* of May 16, 1902. They have been published also in the *Century Magazine* for August, 1902, vol. lxiv, pp. 638-642. The compiler of the latter account in his preliminary note has confounded the Richmond Vale estate with the Richmond estate. Mr MacDonald, fortunately, does not own the Richmond estate, which lies between Richmond and Wallibu Rivers and was destroyed by the eruption. The Richmond Vale estate belongs to the MacDonald brothers and was not seriously injured by the May eruptions, but the September outbursts destroyed the cultivation and damaged the buildings. The house is half a mile northeast of Chateaubelair.

Richmond Vale, was an eyewitness of the great eruption of May 7, and has contributed most valuably to the knowledge of the history of that outburst through the careful notes which he kept of the events of that memorable day, up to the time, 1.55 p. m., when it seemed extremely dangerous to remain longer at his post of observation. He had an unobstructed view of the upper portion of La Soufrière. Mr MacDonald's account of the eruption of the principal day, however, must be prefaced by an extract from the notes of Mr Mathes, a German from South America, who was visiting at Chateaubelair and witnessed the eruption. Mr Mathes says that the first outburst of steam from the crater took place at 2.40 p. m., May 6, and that steam and "smoke" clouds rose from the summit at intervals until 5.40 p. m., when all was clear; but at 6.05 o'clock there was another outburst with a very thick cloud of dust. According to Mr MacDonald, such eruptions took place at intervals of an hour and a half to two hours throughout the night. By 10.30 of the morning of the 7th the outburst had become continuous, the column of steam rising to a height seven or eight times the altitude of the mountain, or at least 30,000 feet. The display of lightning about the column was constant and impressive, being vivid in the extreme. At 1 o'clock large stones could be distinguished in the ascending clouds of steam and dust. These seemed to fall to windward. Tremendous roaring mingled with the thunder and lightning to produce terror in the minds of beholders. Just before 2 o'clock there was a marked increase in the already great activity, with great showers of stones to windward, and "a terrific, huge, reddish and purplish curtain" advanced toward Mr MacDonald's house, causing him to consider discretion the better part of valor and to take to a boat which he had in readiness for the emergency. He and his boatmen thought that they would be overwhelmed by the cloud, but they made good their escape, though many stones fell into their boat.

From 2 o'clock onward of that terrible Wednesday the volcano was enveloped in a dense cloud of dust and steam, from which red-hot rocks fell in torrents, and anything like continuous and calm observation of phenomena was out of the question. The present appearance of the mountain slopes corroborates Mr MacDonald's observation that most of the large stones fell to windward. Stones six inches, and perhaps more, in diameter fell in Georgetown, five and one-half miles in an air line from the crater to the southeast. I observed blocks two feet in diameter in the material from this eruption four miles from the crater, while on the actual slopes of the mountain such blocks even four feet across are to be found. On the leeward side the absence of stones, especially near the crater, is remarkable, but we found some as large as one's head in the débris covering Richmond village, four miles southwest of the crater.

The eruptions continued with abating force for some days after the great outburst of May 7, but, after a few days of quiet, the crater broke out again on Sunday evening, May 18, and the eruption was so violent that there was a heavy shower of stones in Kingstown, the capital of the island, which is about twelve miles distant from the crater in a straight line. This eruption was very short-lived.

The first ascent of La Soufrière since the eruption of May 7, 1902, was made on Saturday, May 31, by Messrs Jaggar, Curtis, MacDonald, and myself, with six porters. We went up from the site of Wallibu village, on the leeward (west) side, following the remains of the old trail across Trespé Valley and along the tops of ridges to the elevation of 1,500 feet above tide, where we came upon

Mont Pelée in Eruption, May 28, 1902

From a photograph taken by Mr George Kennan from Acier and republished from The Outlook of August 2, 1902, by permission of the editors

the remains of the "Half-way tree" lifting its denuded and scarred limbs in mute protest against the terrible devastation all about.

Trespé Valley had a heavy deposit of volcanic ash in it comparable to that in the Wallibu Valley, but secondary steam action in the beds had ceased there by the time of our visit, though we observed crevices through which warm vapors were still rising. There was no direct way of measuring the thickness of the new deposit in this valley, but the principal stream bed was cut down through more than ten feet of it without reaching the old level. From a distance the crests of the radial ridges on the mountain looked like well-trodden paths leading to the summit. This appearance was due to the fine mud forming a sticky mass and remaining on the comparatively flat crest until the newly imposed dendritic drainage advancing up both sides of the ridge should meet along the crest.

The steepness of the ravines cut into the ridges, and of the main gorges as well, hinted strongly at recent topographic features, and at first seemed to indicate an immense amount of erosion during and since the May eruptions. This opinion soon was abandoned by the author on account of the patches of undisturbed surface soil and uncharred roots to be seen here and there on nearly every slope, where the coating of fresh ash had been washed away. Bluffs, however, which had been exposed to the full fury of the volcanic sand blast were stripped of surface soil and roots and showed nearly horizontal scarification as a result of the impact of the wind-driven lapilli. In spite of this scouring and of the evidence of local landslides,

it was clear that no radical change in this phase of the topography had resulted from the eruptions

At 1,500 feet above the sea we encountered slopes coated with soft mud, which usually was from six inches to two feet deep, but which sometimes seemed to be much deeper. This feature prevailed up to the rim of the crater and made travel very laborious. Water soaking into the mass of fine dust had formed this soft mud, and it would not have taken a great additional supply of moisture to turn the mixture into a fluid mass which would rush down the mountain and out to sea as a "mud-flow."

We had started from the ruins of the Wallibu sugar works at 7.30 in the morning, and at 9.49 Mr Curtis stood upon the crater rim of La Soufrière, Dr Jaggar, Mr MacDonald and I following some minutes later. Our elevation was determined to be 2,790 feet above the sea by taking the average of the readings of our three aneroid barometers. We found the crater probably unchanged in diameter, as nearly as Mr MacDonald could tell, and therefore to be about nine-tenths of a mile in diameter from east to west and eight-tenths of a mile from north to south, judging from measurements made on the map. The beautiful crater lake had disappeared, of course, but there was a small lake of boiling water in the bottom of the pit, from the southeastern quarter of which steam was ascending in a strong column. This column at intervals was carrying up quantities of black sand with it to moderate heights above the bottom of the crater. We estimated the surface of the boiling lake to be about 1,600 feet below the point on which we were standing and 2,400 feet below the highest point of the rim, which was on the northeastern side. The lake seemed to be shallow, judging from some nearly flat ground in the bottom of the crater northeast of the water. Our estimate would indicate that the surface of the water was 1,200 feet above the sea, or 730 feet lower than the surface of the old lake.

Almost directly opposite the point where we first reached the rim was the wall and saddle, between the "Old" crater and the crater of 1812, apparently unbroken by the eruption. From the lower third of this series of nearly vertical rock faces and agglomerate beds there issued a strong stream of water which cascaded down the precipices and flowed across a rather narrow strip of nearly level ground in the bottom of the crater and emptied into the boiling lake. It seemed as if this stream must be the discharge of the waters now collecting in the crater of 1812, where there was a little lake before the eruption of the present year. Tremendous avalanches of rocks and earth descended the inner precipitous slopes of the crater at intervals during our stay on the rim. They made a great deal of noise, and may have occasioned some of the "groaning" of the volcano reported by the islanders.

The rim of the crater seemed to be formed all the way round of tuff agglomerate some scores of feet in thickness and sloping inward at an angle of about 30°. The elevation of the crest varied from 2,600 feet to 3,623 feet, according to the chart. Below this bed began a series of beds of solid lava alternating with beds of tuff. Through this portion of the mountain the walls of the crater seemed to be nearly, if not quite, vertical. The beds of lava showed fine columnar structure perpendicular to the surfaces of cooling, and a dike, perhaps forty feet wide, cutting all the series from the bottom of the crater up to a lava bed at 3,000 feet altitude on the north side of the vast pit, showed well-developed horizontal columns. The relative positions of beds and columns on the east side of the pit showed that after the great cone had been built up to an elevation of about 2,500 feet an eruption took place which breached the

cone and sent a stream of lava out to windward. At the close of that eruption the lava filled up the breach, and subsequent eruptions sent flows of lava and threw beds of ash over it.

The western side of the crater rim showed a gash leading into the Larakai Valley, but the bottom of the gash was more than a thousand feet above the bottom of the crater. Mr MacDonald said that the gash was there before the eruption took place, but that it seemed to him to have increased in size since the outbursts began. The gash is very much smaller than that in the southwest side of Mont Pelée, and it does not seem to have had any determinable effect in concentrating the force of Soufrière's volcanic hurricanes.*

On June 4 Messrs Jaggar, Curtis, and I made an attempt at the ascent from the windward side. We reached the altitude of 3,200 feet, but turned back without getting to the crater itself, on account of the dense trade-wind clouds. Dr Jaggar felt obliged to leave St Vincent on the next day, but Mr Curtis and I remained at Georgetown to study the coast line and the Rabaka Dry River and to try the Soufrière again. On June 9 Mr Curtis and I made our third ascent, alone, except for one guide, and reached the rim of the crater on the southeastern side two or three hundred yards beyond the spot at which we had turned back on the preceding occasion. For fifteen or twenty yards back from the edge of the rim there were crevices in the ground many yards long and up to three inches wide, which formed lenses with the edge itself and indicated the imminence of landslides into the crater. We pushed along the rim northward until, at an altitude of 3,550 feet (aneroid) above the sea, we stood between the large crater and the crater of 1812.

The summit of La Soufrière east of the large crater and south of the small one is formed by a rather small plateau which slopes gently toward the southeast, closely analogous in position to the small plateau on the eastern summit of Mont Pelée which was the site of the Lac des Palmistes. This plateau was covered with a bed of dust, lapilli, bombs, and ejected blocks which was ten to fifteen feet thick in places, and the trenches cut by recent rains made traveling very laborious, except near the edge of the crater. The rim immediately above the most active portion of the great crater (its southeastern quarter) was precipitous and almost overhanging. Steam seemed to issue from it almost up to the very edge of the plateau. The steam smelled of sulphur gases.

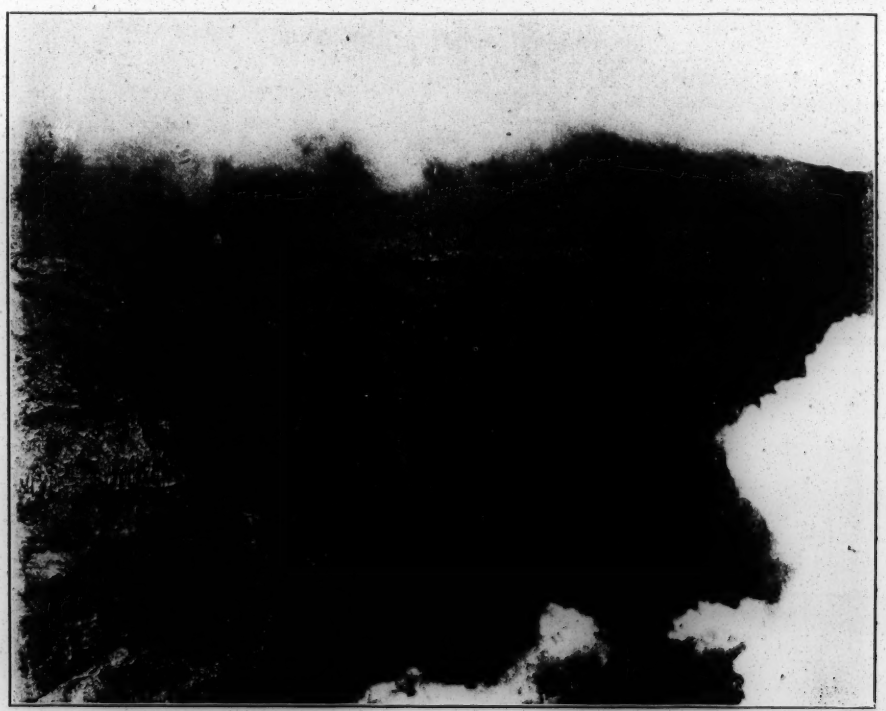
In spite of clouds and rain, this visit, through occasional glimpses of the interior, led me to the conclusion that the crater of 1812, which for nearly a century has gone by the name of the "New" crater, took no active part in the eruptions of May of the present year, an inference based on the following considerations: The saddle between the two craters appeared to be intact, confirming the observation made from the other side of the large crater; a knife-edge ridge which ran at a steep incline from the saddle to the bottom of the small crater and formed the pathway for descent into it before the eruption was still there and had on its slopes bare trunks of trees standing; in the bottom of the crater along the base of this ridge we could see talus slopes of dry (?) dust and lapilli which had slid and rolled down its sides; although the roaring of the steam and boiling water nearly half a mile below us in the large crater was obtrusively discernible, no sound whatever came from within the

* The reports (communicated to me by Mr MacDonald) of persons who have visited the summit of the mountain since the great eruptions of September indicate a further enlargement of this gash, and some "notching" or lessening in height of the saddle between the large crater and the crater of 1812.

crater of 1812; the rim of the small crater showed less and less dust as one receded from the edge of the great crater.

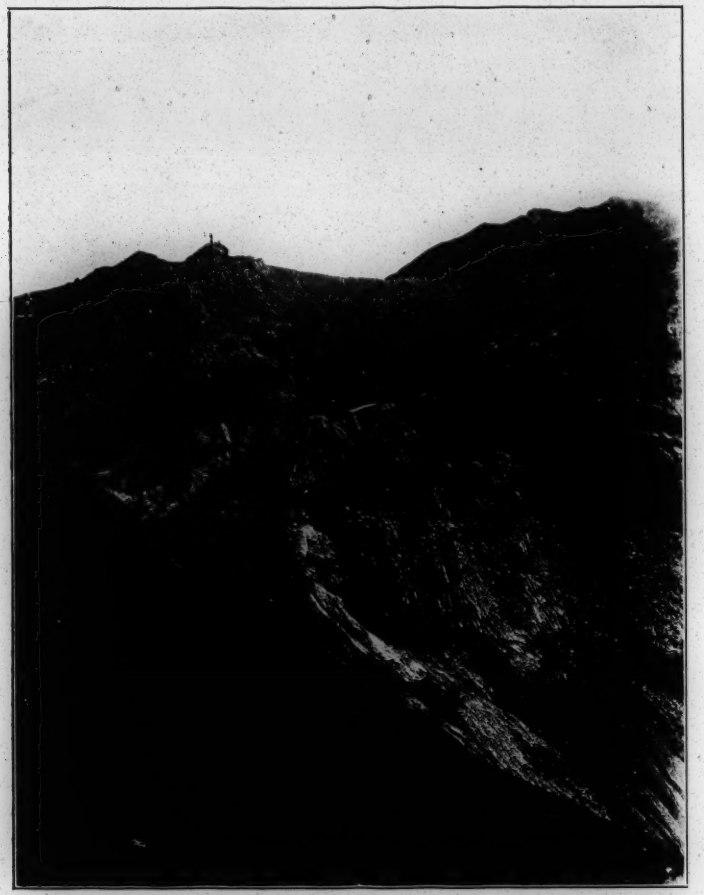
Samuel Brown, a ranger or care-taker on the Lot 14 estate on the southeast slopes of La Soufrière, who was our guide, when we reached the small crater, told us that he watched the eruption of May 7 until the great outburst at 2 o'clock, and that no cloud of steam or "smoke" rose from the small crater. Furthermore, at the time of my leaving the island, June 10, no column of steam had risen above that crater since May 7. Brown was at the sugar factory of the estate, three and one-half miles in a straight line east-southeast from the crater, a most favorable spot from which to observe what was going on at the summit of the mountain. He saved his life by running into the rum cellar of the factory and closing the door and the window shutters just before the volcanic blast swept over the building. On inquiry in Georgetown I found persons who had watched the eruption from the town and had noted the fact that no column of steam rose from the small crater.

Although there are many ancient lava beds in the composition of the mountain, no *stream* of melted lava has issued from La Soufrière during the present eruption. The "bread-crust" bombs, however, which occur plentifully on the mountain sides, especially on the windward slopes, show that during the present eruption molten lava has been present in the throat of the volcano, and that many lumps of melted or half-



La Soufrière. Interior of Crater. Eastern Wall Showing the Alteration of Columnar Beds of Lava with Deposits of Tuff Agglomerate

From a photograph taken by Dr E. O. Hovey, May 31, 1902



La Soufrière. Western Part of Great Crater

From a photograph taken by Dr E. O. Hovey, May 31, 1902

melted rock were thrown into the air. Besides the bombs, the volcano ejected blocks of ancient andesitic lava of several kinds and of varying degrees of coarseness of grain, and of all sizes up to masses six or eight feet across, and vast quantities of coarse and fine lapilli and dust. Most, if not all, of the blocks were thrown out at high temperatures, as is shown by their cracked condition, though they were not actually fused. Although a few bombs, some of which were twelve to fifteen inches across, were found on the leeward side as far away from the crater as the site of Richmond village, three and one-half miles distant, by far the largest number of both bombs and blocks, as well as the largest specimens, were found on the windward side, bombs fifteen to eighteen inches in diameter being common in the bed of the Rabaka Dry River. The proportion of old lavas in the ejecta of La Soufrière seems greater than in those of Pelée, and there is greater variety, apparently, in their composition.

The bombs thrown out by La Soufrière are not as perfect in development as those ejected by Mt Pelée, a difference that seems to be due to the greater basicity of the St Vincent lavas. The more basic rocks, having a lower melting point, would be more nearly fused in the throat of the volcano, or would remain fluid for a longer time than the more acid. Bread-crust bombs seem to be confined to relatively acid lavas. They are typically developed in the andesitic ejecta of Vulcano and Mt Pelé. They are absent from the more easily fused basaltic material thrown out by Vesuvius, Etna and the Hawaiian volcanoes.

The area of devastation on St Vincent is very large in proportion to the total area of the island. After plotting that of the May eruptions out carefully on the British Admiralty chart and measuring the area with a planimeter, I find that it was 46 square miles, practically one-third the entire area of the island. From much of this devastated area, however, the ashes were being washed off so rapidly by the rain that vegetation was already asserting itself by June 10, the date of my leaving St Vincent. The tremendous eruption of September 3, however, is reported to have extended considerably the area of present ruin, particularly on the leeward side of the island. The cable dispatches state that the estates of Richmond Vale, Sharp's, Petit Bordel, Cull's (Swat's?) Hill, Trumaka, and Cumberland have lost all their present cultivation and have lost buildings through crushing, while a private letter from William J. Durrant, of Kingstown, informs the author that much volcanic sand fell as far south as Peter's Hope, five miles below Chateaubelair. On the leeward side of the island, therefore, the boundary line of the zone of destruction probably now is about two miles south of Chateaubelair. The area on the windward side is reported not to have been extended by the September eruption.

Extensive landslides have taken place on the western side, removing a strip of coast, in places one hundred yards wide, continuously from the mouth of the Wallibu River to Morne Ronde village, a mile and a half to the north, and at intervals for two miles farther north. These landslides have left precipitous walls along the shore line, and deep water is found where villages stood and prosperous plantations existed before the eruption. We had no sounding line, but our boatmen could not touch bottom with a twelve foot oar three feet from shore on the site of Morne Ronde village. The sections left by the slides show that the land which has disappeared consisted of delta and coast-plain deposits, material which would easily be dislodged from the more substantial lava, flows and agglomerate beds by the vibrations due to the eruptions. The eastern, or windward, side of the island is not nearly as steep as the leeward, and landslides have not occurred there as features of this eruption. On the contrary, the windward shore line from Black Point, a mile south of Georgetown, northward almost to Chibarabou Point, more than six miles distant, has been pushed out by the vast quantities of fresh lapilli which have been brought down from the slopes of the volcano by the rivers and the heavy rains during and since the eruptions and distributed by the ocean currents. When I was at the locality, on May 27, I noticed that the shore line at the landing jetty of the Rabaka sugar works, a few rods north of the mouth of the Rabaka Dry River, had been extended half way to the outer end of the jetty, a matter of 40 or 50 yards, by the black volcanic sand brought down by the torrents. By June 5 the point had been washed back nearly to the old shore line again and the material distributed along the coast, especially in the little embayments.

A large amount of material was brought down by the Rabaka Dry River

an hour in advance of the great outburst of May 7, which seems to have been due to the bodily discharge of a portion, at least, of the old crater lake into the headwaters of that stream. Survivors who attempted to cross the Rabaka Dry River toward noon of that day report that they were prevented by a torrent of "boiling-hot" water and mud rushing down the valley, and that a wall of water and mud fifty or more feet high (they compared it with the height of a factory chimney) came out of the upper reaches of the river and swept out to sea. There was no heavy rain that day before the eruption took place, but the lake still was in the crater early in the day, according to the tale of a fish-woman who had ascended the mountain from Georgetown that morning on her way home to Chateaubelair. The trail led along the rim of the crater for half a mile. The woman reached the rim at 9 o'clock and found that fissures had appeared in the ground, and that the lake was at a higher level than usual and boiling. She rushed back to Georgetown to warn the people, but her tale was discredited. Mr MacDonald's notes contain the entries: "12.55 p. m.—Enormous discharge to windward side; color, darker. 1 p. m.—Tremendous roaring; stones thrown out to windward thousands of feet."* While this does not *prove* the bodily out-throw of the lake, it shows that there was a great outburst from the crater just in advance of the flood in the Dry River Valley. The dust and lapilli thrown out by the volcano before this hour must have passed through the waters of the lake, as seemed to be happening on a small scale while we were looking into the crater May 31.

It is evident that there was a blast or a series of blasts of hurricane violence from the crater of La Soufrière as well as from that of Mont Pelée, as a feature of the eruptions of 1902. The effects were not so appalling, however, on St Vincent as on Martinique, because no large city was destroyed there. The overturned trees constitute the principal evidence on the island of St Vincent. They all point away from the crater, except for slight modifications due to local topography, and their roots are denuded of bark and show charring on the side nearest the crater, while the farther side preserves the bark uninjured. The trunks of the trees show the same condition—denuded and charred on the side nearest the crater, uninjured on the farther side. The villages of Wallibu and Richmond, on the leeward coast, were in much the same relation to La Soufrière that St Pierre was to Mont Pelée. Wallibu was carried down into the ocean by a landslide during the eruption of May 7, while Richmond was buried under from 5 to 20 feet of lapilli and dust.

The blasts extended radially in all directions from the crater, suggesting the explanation that great volumes of steam, rising from the throat of the volcano, could not find room for expansion upward, on account of the cushion formed by the column of steam and ashes which had preceded them, and the ashes falling therefrom, and that they expanded with explosive violence horizontally and downward, following the configuration of the mountain. This accords with the testimony of Mr MacDonald and other eyewitnesses of the eruptions who say that they saw the clouds of "smoke" (dust-laden steam) rushing down the sides of the mountain with terrific speed. This dust-laden steam was able to do much work of erosion, as is shown by the horizontally scoured sides of some of the exposed cliffs and by the trunks and roots of overturned trees. The roots particularly have been charred by the heat and carved into fantastic, pointed shapes, as if they had been sub-

*Century Magazine, vol. lxiv, p. 639, August, 1902.

jected to the action of a powerful sand-blast. The ordinary erosive action now is that the heavy rains take up vast quantities of the loose lapilli for use as a powerful scouring agent in attacking the denuded hillsides, and thus old valleys are being deepened and widened.

The particular feature of the May eruptions of La Soufrière was the enormous amount of dust which was thrown into the air and distributed over a vast, somewhat elliptical area, the extent of which cannot yet be calculated for lack of data. The British steamship *Coya* had an eighth of an inch of volcanic dust from this volcano fall on her deck when she was 275 miles east-southeast of St Vincent. The steamer encountered the dust at 10.30 p. m., May 7, 8½ hours after the eruption of La Soufrière began, indicating transport against the prevailing surface wind at more than thirty-two knots per hour. Reports of vessels from the west (leeward) of the island have not come to my notice, but the statements of the islanders would indicate that the greater proportion of the cloud of dust went to the east and southeast. The dust was spread like a gray mantle over the island, generally diminishing in thickness from the crater outward, but collected in vast deposits in certain valleys on the sides of the mountain, where the conditions seem to have been particularly favorable. The chief of these beds were formed in the Wallibu, Trespé, and Rozeau valleys, on the leeward (west) side, and in the valleys of the Rabaka Dry River and its tributaries, on the windward (east) slope, with by far the greatest thickness along the Wallibu and Rabaka Dry rivers. In the valley of the Wallibu the deposits were not less than sixty feet deep in places, while in the Rabaka Dry River the fresh material filled a gorge which is said to have been two hundred feet deep before the eruptions began. From a distance this deposit looks as if it were a glacier coming out of the mountains.

The dust began to fall upon the Island of Barbados about 5 p. m., indicating the same rate of transport.

Several other reports quoted in the *West Indian Bulletin*, vol. iii, No. 3, p. 282, agree fairly well with this estimated rate of transport. One report reads: "May 8, bark *Jupiter* from Cape Town met dust at 2.30 a. m., 830 miles E. S. E. of Barbados," which would give a speed of 60 miles per hour. This great rate is so far in excess of what is indicated by the reports of the other ships that discredit is cast upon the report.

The following chemical analysis is of dust which I collected May 27 in a room in the Langley Park estate house, about one mile north of Georgetown, in which 21 dead bodies were found after the eruption of May 7. The analysis was made by Dr W. F. Hillebrand, of the United States Geological Survey, to whom my acknowledgments are due, and is the unpublished analysis referred to in his article in the July number of this Magazine (vol. xiii, p. 297) as emphasizing the greater amount of sulphur present in the ejecta of La Soufrière than in those of Mont Pelée. The absence of chlorine is interesting as indicating fresh waters as the probable source of the steam of the eruptions, in spite of the close proximity of the ocean:

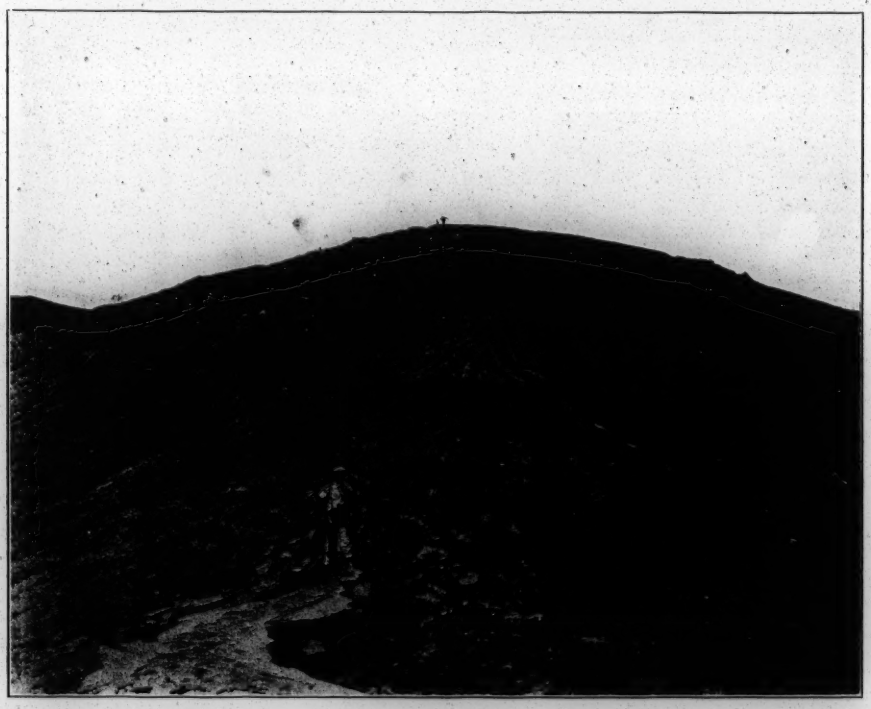
SiO_2	55.08
Al_2O_3	18.00
Fe_2O_3	2.46*
FeO	4.57*
MgO	3.34
CaO	7.74
Na_2O	3.45
K_2O	0.65
H_2O at 100° C	0.66
H_2O above 100° C	1.39
TiO_2	0.80
ZrO_2	(?)
CO_2	None

*Only approximate, because of effect of pyrrhotite, 0.91 per cent. See below.

P_2O_5	0.17
SO_3	0.24
Cl	None, or faint trace
S	(0.36)*
NiO	None
MnO	0.21
BaO	Trace
SrO	None
Li_2O	Faint trace
Fe_7S_8 (?)	0.91
	99.67

*Included in Fe_7S_8 (?).

The September eruptions, though more violent than those of May, deposited less fine dust on St Vincent, according to the newspaper reports and private letters received from Mr T. MacGregor MacDonald and Mr W. J. Durrant, druggist, of Kingstown. Samples of the material ejected by the outburst of September 3 have been received from both gentlemen. The material consists of fine and coarse, gritty volcanic sand and gravel, apparently for the most part comminuted ancient lavas of the volcano. The fragments from 3 to 15 millimeters across show the coarsely crystalline structure of the old lavas, and many of them show that they are parts of weathered masses. Olivine, pyrite (pyrrhotite?) and porphyritic crystals of feldspar, hypersthene, and hornblende are observable in these fragments. The separated minerals make up a large proportion of the particles about 2 millimeters across. A comparatively large fragment (20 mm. in diameter) shows phenocrysts of feldspar imbedded in dark-brown and light-brown scoriaceous volcanic glass which appar-



La Soufrière. Mud Coating Upper Portion of the Cone

From a photograph taken by Dr. E. O. Hovey, May 31, 1902, at an elevation of 1,500 feet above tide

ently is fresh. All the particles are coated with dust, which seems to be as fine as any that fell during the May eruptions. Since the cloud from the September 3–4 eruption of La Soufrière is reported to have produced darkness for about six hours at Fort de France, Martinique, on September 4, it is probable that the fine dust of this eruption was thrown higher into the air than was that of the May eruptions, and was carried northward, away from St Vincent, before it settled.

Such great accumulations of hot lapilli and dust as those in the valleys of the Wallibu and Rabaka Dry rivers retain their heat for a long time, and they have given rise to secondary or superficial eruption phenomena of striking character and considerable interest. The river water and the water from the tropical showers percolating through the beds have come into contact with the still highly heated interior, causing violent outbursts of dust-laden steam. We saw one of these outbursts from the Wallibu Valley send up a column of such vapor fully a mile in height. The action lasted for nearly an hour, and followed directly after a heavy shower.

In the morning of May 30, which was clear and dry, we witnessed the throwing of a dam across the stream and the formation of a temporary lake by a heavy secondary outburst of dust-laden steam from the lapilli bed in the Wallibu Valley. This eruption must have been caused by percolating river water, since there had been no rain for at least eighteen hours when it occurred. After the eruption ceased the little lake soon rose to the top of the dam and quickly cut its way down to the old level, sending a "mud-flow" down the gorge to the sea. Such a lake in the valley of the Rabaka Dry River cut its new outlet through a narrow ridge of the old agglomerate constituting the wall of the canyon, forming as it did so a beautiful series of channel bowls, pot-holes, and scratched corkscrew channels.

When we first reached St Vincent the dust, especially that covering the Richmond estate, showed in marked manner the wind-drift surface so familiar in the case of freshly fallen snow, and in many places these drifts were from three to four feet deep. There were several heavy rains between May 24 and 29, so that the appearance of the surface was very different on May 30 from what it was when I first saw it. Its drifted character was not nearly as evident, and the beautiful dendritic drainage, which was already in evidence on May 24, had been greatly extended and intensified. Geological operations, which under ordinary conditions are so slowly performed as to be imperceptible, were being carried forward rapidly under our very eyes. One item of interest was the action of the Wallibu River itself as it cut into and undermined the beds of dust and lapilli along its banks. Its waters became so overloaded with sediment that they could only flow in pulsations, showing that intervals of time were needed by the stream to gather strength to force its way along with its burden. On May 24 these waves or pulsations were from fifteen to forty seconds apart.* Such mud streams carry large boulders down their beds and have great erosive power.

When the great cloud of ejecta rose from La Soufrière at 2 p. m., May 7, the portion which was traveling eastward seemed suddenly to split, according to the accounts of eyewitnesses, when it was some distance beyond the island, and to send a part back to the land. This is in accord with the fact that unprotected windows in the eastern side (that farthest from the crater) of houses in the devastated district along

*This peculiar action of the Wallibu was first described by the author in a letter published in the *New York Times* of June 29, 1902.

the windward coast were all stripped of their glass, while immense quantities of dust were carried to the Island of Barbados, 90 miles due east, and beyond. The accounts of other eyewitnesses include the mention of a strong blast of volcanic material "returning from the sea" after the main cloud had rushed down the mountain. There probably was an inrush of air toward the mountain, due to the uprushing column from the crater acting on the east side in connection with the trade winds.

An official's estimate of the loss of life on St Vincent by the eruption places the number of killed at 1,350. The actual number of bodies buried was 1,298, including those of the wounded who died in the hospitals. Almost all of the people who passed through the fury of the eruption and escaped uninjured had taken refuge in cellars, the only openings into which were on the side farthest from the crater, and were, moreover, tightly closed with wooden doors or shutters. The most striking example of such protection was at Orange Hill, on the windward coast two and one-half miles north of Georgetown, where one hundred thirty-two persons were saved unharmed in an empty rum cellar. This cellar, which is only partly underground, is part of a sugar factory situated on a rather flat divide between two ravines, which may have tended to separate the volcanic storm somewhat, though the roof of the building over the cellar was demolished by the ejecta. The only openings into the cellar were a door and two windows on the side opposite the crater, and these were provided with heavy wooden shutters which were kept closed during the fury of the eruption.

The manager of the estate, Alexander McKenzie, with his wife and a son, remained in the manor house, scarcely a hundred yards from the rum cellar, and were killed during the eruption, apparently by asphyxiation. The house had large windows, the glass of which was shattered by the projectiles from the volcano, permitting free entry to the deadly dust-laden steam. These three Scotch people and a Portuguese employé at the Wallibu sugar works, on the leeward side, were the only white people killed by the eruption. The experiences of the people in the cellars suggest the great desirability of constructing similar places of refuge for use in time of hurricane as well as of volcanic eruption.

The deaths on St Vincent seem to have been due, principally, to the following causes: (1) asphyxiation by hot, dust-laden steam and air; (2) burns due to hot stones, lapilli, and dust; (3) blows by falling stones; (4) nervous shock; (5) burning by steam alone, and (6) strokes of lightning The last-mentioned cause is perhaps somewhat doubtful, for though it is very generally named by the survivors, there has been no substantiation mentioned beyond the fact that there was a great deal of extremely vivid lightning during the eruption. The action of steam would account for the burns received underneath the clothing where the clothing was not even charred. Sulphur dioxide, SO_2, and hydrogen sulphide, H_2S, were observed in troublesome quantities in the steam coming from the crater, and it is more than probable that these gases, especially the former, added very materially to the deadly character of the dust-laden steam. Strange as it may seem, not an autopsy was made on any of the hundreds of victims of the catastrophe, so that it never can be known definitely what part was played by these or other poisonous gases in the destruction of human life.

APPENDIX

The following additional notes regarding La Soufrière have been derived from private letters and other sources since the foregoing article was sent to the printer:

From a pamphlet by Mr Huggins, printed in St Vincent and entitled "An account of the eruptions of the St Vincent Soufrière," the following table (page 25) has been taken (see page 445 in this number):

Table of Soundings in the Crater Lake of the Soufrière in St Vincent Taken by P. Foster Huggins During 1896 to 1900.

Date.	Distance from shore.	Point from which taken.	Depth.
Nov. 1896	4 feet	West...	4 feet
	6 "	West...	6 "
	8 "	West...	23 "
	10 fathoms	West...	25 fathoms
	20 "	West...	35 "
	40 "	West...	53 "
	60 "	West...	83 "
	100 " (about).	West...	
1900	12 feet	East ...	40 feet
	100 "	East ...	112 "
	50 "	East ...	150 "
	40 fathoms	East ...	47 fathoms
	60 "	East ...	
	100 " (about).	East ...	78 "
	Center	East ...	86¼ "
1898-'9	C ose rocks	South..	2½ "
	40 feet	South..	6 "
	80 "	South..	28½ "
	40 fathoms	South..	52 "
	60 "	South..	63¼ "
	80 "	South..	74 "
	100 " (about).	South..	81 "
	Center	South..	87½ "
1900	20 fathoms	South..	36 "
1896	4 feet from rock..	North..	5 "
	20 " " " ..	North..	16 "
	60 " " " ..	North..	43 "

From T. MacGregor MacDonald, Esq.: On Tuesday, August 19, three young men by the name of Richards (residents of Kingstown) ascended the mountain, and found the crater to be in apparently the same condition as we found it May 31. Mr MacDonald ascended a few days later, and found the same, except for greater volumes of steam rising.

Paul Chastenet (communicated by Mr MacDonald) states that at 9.25 p. m., August 30, "halos" appeared in atmosphere near Chateaubelair at the time when detonating noises (from Mont Pelée) were being heard in St Vincent. Two circular concentric bands of light came toward the town from La Soufrière. When near the town the bands expanded and separated into four concentric rings and faded away toward Chateaubelair Island. These would seem to be an electrical phenomenon.

Wednesday night and Thursday morning, September 3 and 4, occurred the eruption already referred to in the body of this article. The notch in the crater rim on the west side over Larakai Valley seemed to Mr MacDonald to have been enlarged by this eruption. On September 6, at 4 p. m., a column of dust-laden steam rose from the crater to an elevation of between five and ten thousand feet. On September 12 steam was rising vigorously from the western part of the crater, and during the afternoon of the 13th there were several lofty discharges, sometimes from the western side of the crater, sometimes from the eastern, and sometimes from the middle.

September 14, 8.25 p. m., vigorous and continuous escape of steam, five to ten thousand feet into air, from western side of crater; mountain entirely free from atmospheric clouds.

September 17, Messrs J. Adams and W. Cummings ascended the mountain. They found the crater filled with lapilli to about the level of the old lake, as it existed before May 7. There was a sloping surface from all sides toward a depression in the middle. This slope could have been descended from almost any point of the rim. Steam was issuing from several openings, but most vigorously from the extreme east of the crater. Around the central opening there was "mud," and from the opening "fire" [incandescent stones?] was being discharged to moderate heights at intervals of two or three minutes. Cum-

mings stated to Mr MacDonald that the east-west diameter of the crater seemed to have been increased, and the saddle between the large and the small crater was more deeply notched than before.

At about 1 a. m., September 18, there was a comparatively slight eruption of La Soufrière. On the following day (the 19th) Mr Cummings, accompanied by Rev. Mr T. Huckaby, of Chateaubelair, again ascended to the rim of the crater. They found that the crater had been cleared of the ashes observed there on the 17th, and that it had been restored to the condition of May 31, with a small amount of water in the bottom of a vast pit.

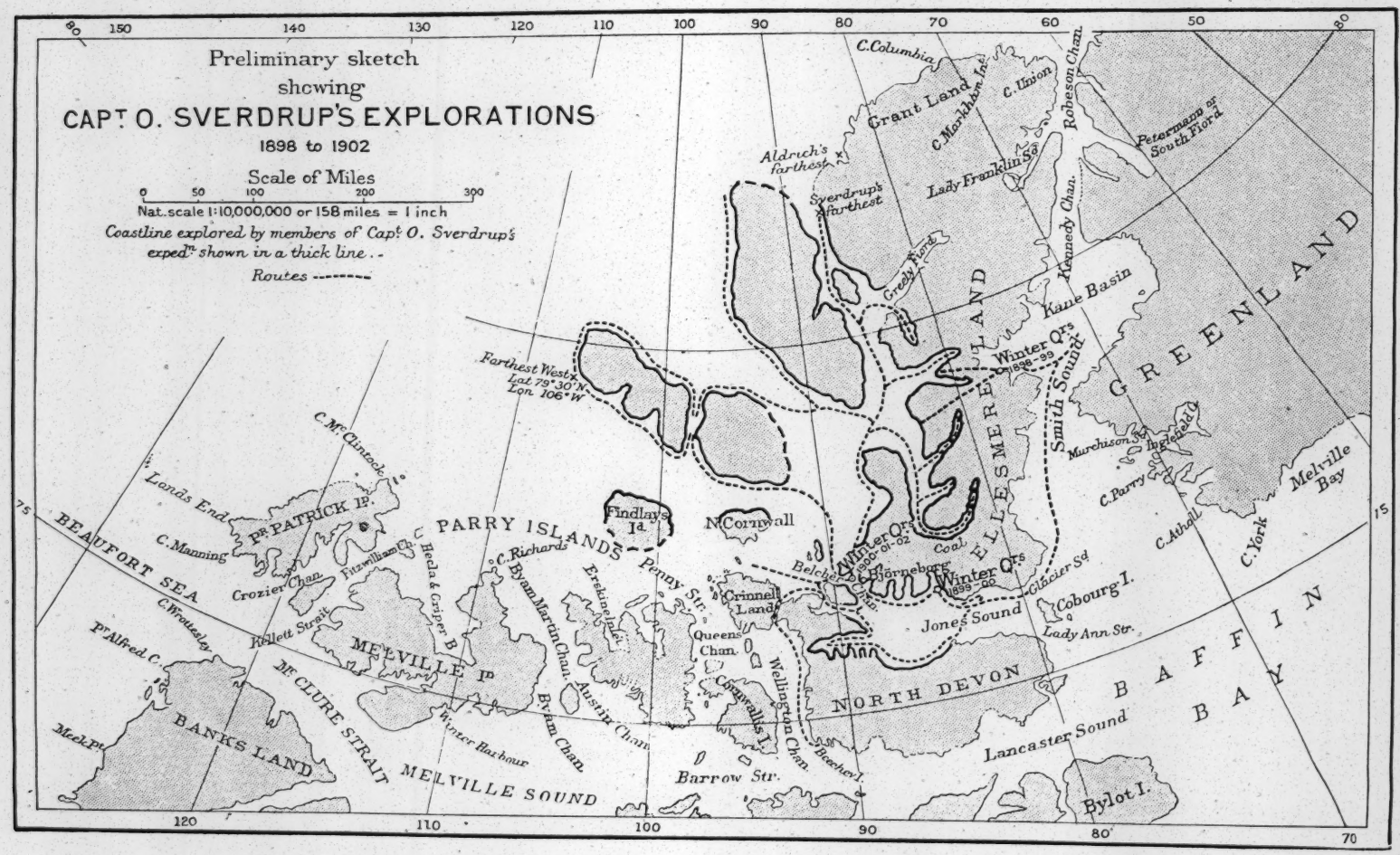
Sunday, September 21, at 6 p. m., there was a violent eruption, which lasted but ten minutes in its vigorous stages. Much incandescent material is reported to have been thrown out during this outburst, but this statement is doubted by Mr MacDonald on account of the red glow from the setting sun. The eruption seemed to come from the northwest side of the crater, and was accompanied by horizontally projected clouds.

On September 24 there was a sudden eruption at about 2.30 p. m., which lasted about half an hour. The solid matter thrown out in this outburst must have been coarse and heavy, for it all fell to the ground and sea in a short time and the horizon was perfectly clear by 3.30 o'clock.

Under date of October 24, Mr W. J. Durrant writes me, after mentioning the outbursts of September 18 and 21, that there was a slight eruption on October 1 at 6.35 p. m., and he then goes on to describe the great eruption of October 15, which he considers the most violent of the series. He states that the eruption began at 8.15 p. m. (the Kingstown *Times* reports the beginning to have been at 7.45 p. m.) and continued in violence till 9 o'clock, when there was a lull. The volcano burst again into full eruption at 1 o'clock the same night and continued in this condition till 5 a. m. The eruption was accompanied by tremendous roaring and a magnificent electric display like that of September 3–4. The sand-and-dust clouds went to windward, depositing much material at Georgetown and northward, while southward great damage was done in the Mesopotamia Valley, where 12 inches of ashes fell. After the great outburst the volcano continued in considerable activity, with minor eruptions, until October 22, when a moderately heavy eruption took place, which threw dust on Richmond estate and Chateaubelair. The encroachments of the sea upon the leeward coast of the mountain continue, especially at the mouth of the Wallibu River.

The Kingstown *Sentry* of October 31 contains an account of the ascent of La Soufrière made on October 28 by Mr Henry Powel, curator of the botanical station on St Vincent, in company with Messrs J. P. Quinton and E. W. Foster, visiting botanists, in spite of the continued activity of the crater. They ascended the mountain from the leeward side and found the journey very difficult on account of the erosion which has taken place since the early eruptions. They found the crater more funnel-shaped than had preceding visitors, but with boiling muddy water in the bottom. Hot ashes, which were steaming profusely, were piled several hundred feet high against the walls of the pit. Coarse gravel and fragments of rock covered the exterior slopes of the cone. The saddle between the two craters is still existent, and Mr Powel was satisfied that no eruption had come from the small crater. No stream of lava has been ejected yet. The rent in the crater on the western side has been enlarged.

At 8.15 p. m., October 29, a loud groan was heard from La Soufrière, followed by a column of dark vapor, and further eruptions were feared.


Preliminary sketch
showing
CAPT. O. SVERDRUP'S EXPLORATIONS
1898 to 1902
Scale of Miles
0 50 100 200 300
Nat. scale 1:10,000,000 or 158 miles = 1 inch
Coastline explored by members of Capt. O. Sverdrup's expedn. shown in a thick line.
Routes
GREENLAND
ELLESMERE LAND
Grant Land
C. Columbia
C. Markham Int.
C. Union
Robeson Chan.
Petermann or South Fiord
Aldrich's farthest
Sverdrup's farthest
Lady Franklin Sd.
Kennedy Chan.
Greely Fiord
Kane Basin
Winter Qrs 1898-99
Smith Sound
Murchison Sd.
Inglefield G.
C. Parry
C. Athol
C. York
Melville Bay
Farthest West Lat 79°30'N Lon 106°W
C. McClintock
Lands End
Pr. PATRICK Id.
C. Manning
BEAUFORT SEA
Crozier Chan.
Fitzwilliam Ch.
Hecla & Griper B.
PARRY ISLANDS
C. Richards
Findlay's Id.
N. Cornwall
Penny Str.
Winter Qrs 1900-01-02
Coal
Winter Qrs 1899-00
Björneborg
Belcher Chan.
Crinnell Land
Glacier Sd.
Cobourg I.
Jones Sound
Lady Ann Str.
Kellett Strait
C. Wrottesley
Pr. Alfred C.
MELVILLE Id.
Byam Martin Chan.
Erskine Inlet
Queens Chan.
Wellington Chan.
Cornwallis I.
NORTH DEVON
BAFFIN BAY
Lancaster Sound
Bylot I.
Meek Pt.
BANKS LAND
McCLURE STRAIT
Winter Harbour
Byam Chan.
Austin Chan.
MELVILLE SOUND
Barrow Str.
Beechey I.
80 150 140 130 120 110 100 90 80 70 60 50 80
75 75
120 110 100 90 80 70

GEOGRAPHIC NOTES

SVERDRUP'S WORK IN THE ARCTICS, 1898–1902

THE map on the opposite page shows the routes followed and coastline explored by Captain Sverdrup in his four years of Arctic work. In the November number of the *Geographical Journal* Sir Clements R. Markham, President of the Royal Geographical Society, has summarized the work of Sverdrup and his gallant companions as follows:

"They have discovered the western side of Ellesmere Island and its intricate system of fiords, as well as three large islands west of Ellesmere Island; they have explored the northern coast of North Devon; they have connected Belcher's work with the coasts of Jones Sound; they have reached a point within 60 miles of Aldrich's furthest; and they have discovered that land north of the Parry Islands, the existence of which was conjectured, as far west as the longitude of the eastern coast of Melville Island. This includes the discovery of the northern sides of North Cornwall and Findlay Island. In addition to the main Arctic problem which is thus solved, it is likely that the region discovered will be of exceptional interest, from the winds and currents, the varying character of the ice, the existence of coal beds, and the abundance of animal life. A systematic survey has been made of these important discoveries, checked by astronomical observations. We must look forward to an account of these things, and to the details of the expedition, with the deepest interest; and meanwhile we may well express admiration for the way in which the work was conceived and executed, and at the perfect harmony with which all loyally worked under their chief. Without such harmonious work success was not possible."

VOLCANIC DISTURBANCES IN GUATEMALA

REPORTS from Guatemala tell of devastation and death by the recent eruptions of Santa Maria as horrible as the tragedies of St Pierre and St Vincent. Santa Maria is a volcano in western Guatemala, about 50 miles from the Pacific coast. It began to erupt October 25 and continued more or less active until November 9.

"The country for a radius of over 30 miles has been made a desolate waste, and every vestige of life destroyed. The loss of life is estimated at over 7,000, the great majority of the victims being Indians. Ten Indian villages, each with a population of from 50 to 5,000 inhabitants, were wiped out, the rude huts being buried beneath tons of volcanic débris. All of the coffee plantations in the volcanic zone are ruined, and their owners left penniless. The greatest distress prevails throughout the central and western portions of the republic, and even on the eastern coast the effects are felt in the scarcity of money and the rise in exchange.

"A famine prevails at Quezaltenango, and 10,000 people are starving. Even in Guatemala City, the capital, the inhabitants are suffering for food. The government is utterly unable to relieve the distress and suffering, and the people are on the verge of revolution. The only thing needed to start a formidable uprising is the appearance of a leader."

Porfirio Herrera, who owned a valuable coffee plantation seven miles from the volcano, gives the following account of the eruption.

"The eruption ceased on the morning of November 9, when I ventured to my plantation and found it buried beneath ten feet of ashes, mud, and sand hurled from the volcano. Everything on the place was in ruins.

"My residence was destroyed, and out of 112 laborers employed on the plantation all but seven perished. The seven who escaped happened to be visiting a farm eight miles farther from the volcano that day, and when they saw the danger took refuge with a lot of others in a cave. My family was in Guatemala City, and therefore escaped.

"On the trip to my plantation I passed a number of other large coffee plantations which had shared the same fate as my own. The scene along the route was frightful. The dead bodies of Indians and animals, who had been suffocated by the deadly fumes, were visible everywhere, and the stench was awful. I passed through one Indian village where over 350 had perished. All of the bodies had their hands to their nostrils, showing plainly what caused death. The damage to the country is beyond repair.

"Two new craters had been formed in the mountain side, and were in eruption at last accounts."

EXPLORATIONS AROUND MOUNT McKINLEY

THE Brooks Alaskan expedition of 1902 fulfilled in the main the program of work in the Mount McKinley region outlined by Mr Brooks in the April number of this Magazine, p. 134. Eight hundred miles were traversed, probably the longest journey with a pack train ever made in Alaska. An instrumental survey was made throughout by Mr Raeburn and his observations made to connect with his surveys in 1901 beyond the Yukon. Thus in the two years' work a belt has been surveyed from Cook Inlet to the Arctic Ocean, a distance of 2,000 miles, and a record for reconnaissance work in Alaska. Evidences of glaciation were found everywhere from Cook Inlet to Tanana up to altitudes of 4,000 or 5,000 feet. Dr Brooks reports the Mount McKinley region probably the best game country in the world. Deer, caribou, bear, and birds were constantly in sight, and so tame that they could knock them with a stick. As elsewhere in Alaska, the mosquitoes incessantly attacked them in clouds, except for four or five hours at night time, from 10 to 3, when the party obtained some rest.

The remarkable magnetic disturbance which attended the eruption of Mont Pelée on May 8, 1902, and which was noted in the June, 1902, number of this magazine, page 208, was recorded at practically all the magnetic observatories throughout the world. This extended magnetic disturbance is something entirely new in our history of volcanic action, as no magnetic disturbance has previously been noted and recorded as attending a volcanic outburst. The data and observations recorded in May, 1902, at the various magnetic stations in the world have been collected by the Magnetic Division of the U. S. Coast and Geodetic Survey. A study of these observations is now being made by the Survey under the direction of Dr L. A. Bauer, and in due time an announcement of the results will be made.

Dr Walter Reed, who freed Cuba of yellow fever, which had scourged the island for centuries, died at his home, in Washington, D. C., November 23, 1902. By his discovery that the yellow-fever germ is carried by mosquitoes, he has made the northern tropics habitable in a true sense. The importance of his discovery is considered second only to Jenner's discovery of vaccination. Dr Reed had only reached his fifty-second year, but he had the satisfaction of knowing that, as a result of his study and efforts, not a single case of yellow fever had occurred in Habana during the last year of his life.

Dr David T. Day, Chief of the Division of Mineral Resources of the U. S. Geological Survey, has been elected a member of the Board of Managers of the National Geographic Society to fill the unexpired term of Mr Henry Gannett. As Mr Gannett will remain in the Philippines for a year or more, engaged in the census of the islands, he has resigned temporarily from the Board. Dr Day was a member of the Board 1896–1899.

In November, 1902, the remains of Christopher Columbus were buried with great pomp for the fifth time. Their last and, it is hoped, permanent resting place is a special mausoleum in the grand Cathedral of Seville. From Valladolid to Seville, from Seville to Hispaniola, from Hispaniola to Habana, and from Habana to Seville again, is the strange story of the journeying of Columbus' remains.

GEOGRAPHIC LITERATURE

Father Marquette. By Reuben G. Thwaites. Illustrated. Pp. 244. New York: D. Appleton & Co. 1902. $1.00 *net.*

The work of Father Marquette as an explorer of the Mississippi, as a preacher, and a friend of the Indians won for him a prominent and lasting place in the hearts and imagination of the American people. His name stands for what has been best and noblest in the history of white men's dealings with the Indian. This biography by Dr Thwaites is especially welcome, inasmuch as, except for brief biographies of Father Marquette by Sparks and Shea, no other has been published. The volume consists mainly of an account of the long canoe voyage (1673) of Marquette and Joliet from Lake Michigan to Portage on the Wisconsin River, thence down the Wisconsin to the Mississippi, which they descended to the mouth of the Arkansas, and then back again up the Mississippi to the mouth of the Illinois, and up the latter and the Chicago to the west shore of Lake Michigan, a journey of over 2,500 miles. By this voyage the explorers proved that the great river of the west flowed to the Gulf of Mexico and not to the Pacific or to the southeastward through Virginia. Marquette was so weakened by the fearful hardship of the four months' canoeing that he died in 1675, at the early age of 38 and after only nine years of service in America. Joliet lost his narrative and maps of the exploration, but the journal and maps of Marquette were preserved long enough for a copy to be made of them, and this is the only record we have of one of the most remarkable explorations in American history.

The Land of Nome. By Louis McKee. Pp. 260. New York: The Grafton Press. 1902.

Mr. McKee gives a vivid picture of the blindness of the stampede to Nome of 18,000 fortune-hunters in the summer of 1900. The past neglect, the present needs, and the untold resources of our wonderful Alaska are described. To quote from the author:

"Uncle Sam's record in Alaska has not been one to be proud of. A taxed, unrepresented people, who, under the greatest adversities, have shown to the world the enormous and varied resources of a supposedly barren land, have for years had to bear the additional burden of incompetent and unscrupulous officials who have been foisted upon the country. The rush to Cape Nome has attracted attention to only a compara-

tively insignificant portion of Alaska, and emphasized but one of the treasures in its vast, unexplored storehouse.

"In the north and east, and over by the Canadian border-line, is the world-famous Klondike region. Fifteen hundred miles distant to the west, close to Siberia, are the Nome gold-fields. Southeast are found seemingly inexhaustible quartz-gold mines, the greatest salmon fisheries in the world, and a climate and soil which will make agriculture possible and profitable. And away to the south and west are immense forests, mines of copper, and the Pribilof Islands, the home of the fur-seal. Within the boundaries of Alaska there lies a country incomprehensible in its extent and difficulties, inconceivable in the possibilities of its latent wealth. The marvelous discoveries of gold at Cape Nome, which have entailed so much hardship and scandal, bringing riches to many and disappointment to more, will at least have worked a highly beneficent result in bringing earlier to light the neglect and needs of our wonderful Alaska."

Journey to Lhasa and Central Tibet. By Sarat Chandra Das. Edited by W. W. Rockhill. Illustrated. Pp. 285. London: John Murray. 1902.

The author of this volume was born of a Hindu family of the medical caste in Eastern Bengal, in 1849. In 1879 he entered Tibet and remained for six months at Tashilhunpo, a great center of lamaist learning, as the special guest of the Prime Minister. He had previously thoroughly mastered the Tibetan language, and was thus equipped to gain the most from this opportunity for research. In November, 1881, Sarat Chandra started on his second journey to Tibet, and this time succeeded in making a short visit to Lhasa and extended explorations along the Tsangpo. On his return to India in 1883 he began editing and publishing in English text some of the 200 manuscripts and volumes he had brought back with him. The present volume is a narrative of his second expedition to Tibet. The illustrations in the volume are very clear and give a good idea of the people and country. Two photographs of Lhasa are specially noteworthy—one a general view of the mysterious city and one showing the imposing palace of the Grand Lama.

Prisoners of Russia. By Benjamin Howard. Illustrated. Pp. 389. New York: D. Appleton & Co. 1902.

In 1891 Dr Howard passed several weeks in Sakhalin, the island on the northeastern coast of Asiatic Russia where Russia sends her most dangerous criminals and such politicals as are considered equally dangerous. Dr Howard died before this volume of his observations was published, and in his stead Gen. O. O. Howard, a personal friend of the author, contributed the preface. Sakhalin is as long as England, about 650 miles, but her width is less, ranging from 50 to 150 miles. There were about 12,000 convicts on the island at the time of Dr Howard's visit. Several chapters are devoted to describing the island, the life of the convicts, their work, punishments, etc., and then several chapters to a discussion of the relative merits of the Siberian and Anglo-American penal systems. Dr Howard concludes the comparison as follows: "In America and England, but perhaps in England more especially, the administration is remarkably good, the principles outrageously inhuman and bad. In the Siberian system the administration has rarely been good and frequently has been outrageously bad, but, as regards the general principles of the Siberian system, they are in accordance with the constitution of man, of laws, both natural and revealed, and are therefore exceedingly good." Dr Howard was the author of the "Direct System of

Artificial Respiration" which is generally used throughout the world for resuscitating persons seemingly drowned.

The East of Today and Tomorrow. By Bishop Henry C. Potter. New York: The Century Co. 1902. $1.00 *net.*

In this little volume Bishop Potter presents some of his impressions of the Far East, which he visited after the Boxer uprising had been crushed. He believes that China is at last awakening from her torpor, and, recognizing her deficiencies, is reaching out to Japan for help and guidance in correcting them. Bishop Potter's broad and humane view of the Chinaman is the best feature of a book which in other respects contains very little that is new. The Chinaman speaks extravagantly; the westerner speaks directly. Because the westerner does not find the words of the Chinaman fulfilled literally is no reason, says Bishop Potter, for calling all Chinamen liars.

Report of the Smithsonian Institution for the year ending June 30, 1901. Illustrated. Pp. 782. Washington: Government Printing Office. 1902.

The first part of this annual includes the proceedings of the Board of Regents, the report of the Executive Committee of the Board, and the administrative reports of the Secretary and of the heads of the scientific bureaus under the Smithsonian. The great bulk of the volume, practically four-fifths, is devoted to the general appendix, in which are presented a series of popularly written articles summarizing scientific progress in various lines during the year. Among the articles of a geographic interest may be mentioned: "Forest Destruction," by Gifford Pinchot and C. Hart Merriam, who emphasize the almost certain annihilation of the fauna and flora which follows the disappearance of the forest; "The Abbott Collection from the Andaman Islands," by Lieut W. E. Safford, an interesting description of an island people who from earliest times have been considered one of the most savage races in existence and whom Dr Abbott declared the "very blackest people I have ever seen;" "Irrigation," by F. H. Newell; "A Fire Walk Ceremony in Tahiti," by S. P. Langley (portions of this paper appeared in the NATIONAL GEOGRAPHIC MAGAZINE of December, 1901); "The Wanderings of the Water Buffalo;" "The Dinosaurs or Terrible Lizards," by F. A. Lucas, and "Bogoslof Volcanoes," by C. Hart Merriam. Some of the papers are reprints, while others were written specially for the report.

Annals of Switzerland. By Julia M. Colton. Illustrated. Pp. 301. New York: A. S. Barnes & Co., 1897. Republished 1902.

The author aims to present a "brief consecutive narrative of the struggles, progress, and attainments of a race of freemen." Miss Colton pays proper deference to the traditions which "belong as truly to the land as do its glaciers and avalanches," and which in the telling have stirred and ennobled the ambitions of generations on generations of the people.

Forestry in Minnesota. By Samuel B. Green. Illustrated. Pp. 401. Published by the Geological and Natural History Survey of Minnesota. 1902. 37c. postpaid.

This volume is a second and enlarged edition of an admirable work first published in 1898. It has been used with success as a text-book in many agricultural colleges and normal schools in the United States. The first half of the book Dr Green devotes to "Elementary Forestry," including chapters on "Tree Planting," "Nursery Practice," "Forest Protection," "Wood and its Uses," and "Forest Economics." The second half is a description of the "Trees of Minnesota," concluding with a list of the forest trees of the United States.

PROCEEDINGS OF THE NATIONAL GEOGRAPHIC SOCIETY

ANNOUNCEMENTS

REGULAR MEETINGS:

December 5.—"The Work of the Weather Bureau." Dr Willis L. Moore.

December 19.—"The Work of the Signal Office, War Department." Gen. A. W. Greely.

January 2.—Annual meeting. Reports and elections.

January 16.—"The Work of the Hydrographic Office, Navy Department." Commander W. H. H. Southerland.

January 30.—"The Work of the Office of Experiment Stations, Agricultural Department." Dr A. C True.

February 13.—"The Work of the Census Office." Hon. William R. Merriam.

February 27.—"The Work of the Naval Observatory." Capt. Charles H. Davis.

March 13.—"The Work of the Geological Survey." Hon. Charles D. Walcott.

March 27.—"The Work of the Library of Congress." Hon. Herbert Putnam.

POPULAR LECTURES:

December 12.—"Argentina—Present and Future." E. L. Corthell, C. E. (Illustrated.)

January 9.—"The Turk and His Rebellious Subjects." Mr William E. Curtis. (Illustrated.)

January 23.—"The Tragedy of St Pierre." Mr George Kennan. (Illustrated.)

Provisional arrangements have also been made for lectures on Colombia and the Isthmian Canal; America Before the Advent of Man; The Geographic Distribution of Insanity in the United States; Russia of Today (by Paul du Chaillu), and a lecture by Mr John Muir.

The Lenten Course of five lectures will be delivered in Columbia Theater, F street, near Twelfth, at 4.20 o'clock, on Wednesday afternoons of February 11, 18, 25, and March 4, 11. The subject of this course and the speakers assigned for the special topics will be announced in a later program.

November 7, 1902.—The first regular meeting of the Society for the year 1902-1903 was held in the Assembly Hall of the Cosmos Club at 8 o'clock p. m., Acting President W J McGee, LL. D., in the chair. Hon. William F. Willoughby, Treasurer of Porto Rico, delivered an address on "Some of the Administrative and Industrial Problems of Porto Rico." An abstract of the address follows:

In assuming the responsibility of the government of Porto Rico the American authorities found themselves confronted with two distinct but yet related tasks: (1) To endow the newly acquired possession with political institutions and systems of law at once conforming to American ideals of individual liberty and political justice and yet adapted to the peculiar local conditions existing and the character of the inhabitants, and (2) to bring about a development of the industrial resources of the island.

The general policy of the United States has been (1) to administer the island solely with a view to its own interest, and in no way as a source of revenue to the federal treasury, and (2) to endow the island with the largest measure of local self-government that it is fitted to enjoy.

In carrying out the first part of this policy not the slightest effort has been made by the United States to recoup itself for expenditures incurred during the war resulting in the annexation of the dependencies nor the expense subsequently incurred for their administration and development while under military government; but it has been provided that in the future, or for an indefinite time to come, all receipts in the way of customs duties or excise taxes collected in the island shall be turned into the insular treasury instead of the federal treasury. In consequence of this provision, the island enjoys an enormous advantage over what it would have were it a state or organized territory of the Union. Over two-thirds of the revenue of the island of Porto Rico is obtained from these two sources of excise taxes and customs duties, which in the United States would be covered into the general treasury. While thus foregoing the receipt of any revenue from the island, the United States not only exercises a general care of Porto Rican interests in the way of military and naval protection, but performs at its own expense such industrial and commercial services as the maintenance of light-houses and harbor buoys, a marine hospital service, a weather bureau, etc., and has also recently established an agricultural experiment station on the island, and contemplates conducting very important experiments and investigations for the development of the agricultural resources.

The execution of the second feature of the policy can be only gradually accomplished. It may be said to comprehend three phases: (1) The immediate endowment of the island with the maximum measure of self-government that the educational and moral attainment of its inhabitants and the training that they have had in the management of public affairs qualify it to enjoy; (2) the administration of affairs in the dependency with the distinct aim in view of educating the population in a knowledge of the true principles and order of political action and the cultivation of habits of political morality, and (3) the actual extension of the local or self-government that was first granted to the dependency as rapidly as success is attained in these educational efforts.

From the foregoing it will be seen that in the management of its dependencies the United States has to deal with what is a dual problem—that of government proper and that of the education in the knowledge and principles of government of the people governed. This duality of the task should never be lost sight of in any study of the problem or in an attempt to judge of the success achieved in its solution. The work to be done is rendered enormously more complicated and difficult in consequence of the adoption of this second aim.

The first step for the organization of a permanent civil government for the island was taken by Congress through the passage of the "Foraker act," approved April 12, 1900. This act provided for the organization of a civil government, to take effect May 1, 1900. It attempts to do nothing further than provide a bare outline of government. It specifies that the government of the island shall be vested in certain bodies and offices, and outlines their respective fields of authority. Here it stops. All the details of the organization of an actual administrative machinery and the determination of the methods of work are left to the subsequent actions of the government thus created.

The government of the island is vested in an executive consisting of a governor and six heads of administrative departments—the secretary, attorney general, treasurer, auditor, a commissioner of the interior, and commissioner of education—and in a legislature composed of two houses—an executive council, or upper house, and a house of delegates, or lower house. The governor and the six heads of departments are appointed by the President. To the legislative assembly of two houses, known as the house of delegates and the executive council, is given full power to legislate regarding all matters relating to Porto Rico, subject only to the provisions of the organic act and to the laws enacted by the Congress of the United States.

The sessions of the legislature are limited to 60 days each year, beginning with January 1, though extra sessions may be called in the discretion of the governor. All bills may originate in either house, but no bill can become a law unless it receives a majority vote of all the members belonging to each house, and is afterwards approved by the governor within ten days after its passage. The governor has the usual power of veto.

The house of delegates constitutes the popular branch of the legislature. It is through this body that the people of Porto Rico exercise a real voice in the administration of affairs. It is composed of 35 members, elected annually by the qualified voters of the island. The determination of the right of franchise was left by the organic act to the insular legislature. In pursuance of this power a comprehensive election law has been enacted, patterned after the system in force in the United States, which in turn is that known as the Australian or secret ballot system. By the law the franchise is given to every male citizen of Porto Rico or of the United States of the age of 21 years and upwards who shall have resided in Porto Rico for one year preceding the date of election, and for the last six months within the municipal district where the vote is cast, who possesses any one of the three following requirements:

(1) Able to read and write.
(2) Owns real estate.
(3) Pays taxes.

At the elections, which are held on the same day as the elections in the United States, the voters vote for delegate to Washington, members of the house of delegates, and municipal officials.

The disorders that occasionally take place during the heated campaign preceding the elections are without significance. While indicative of a certain lack of self-restraint, they are in no way indicative of the inability of the islanders to work under an election system. It is difficult to persuade the voters that all will be given a fair show, but as soon as this fact is established the violence will become less and less.

The executive council is the center or key to the government. The eleven members which constitute it are appointed by the President. Six of the members are also heads of the administrative departments, and in practice have heretofore been Americans. The other five members have in practice been native inhabitants of Porto Rico. The executive council has equal legislative powers with the lower house and may initiate legislation. As no legislation may be passed without the assent of both legislative bodies, the majority of the council, the six heads of the departments, in a certain sense can control legisla-

tion, but on the other hand they cannot secure legislation without the consent of the lower house. As a consequence any measure to become a law must meet with the approval of the representatives, both of the United States and Porto Rico. Hence the mutual recognition of the rights and desires of the two houses is necessary in order that the governmental machine can be made to work.

No greater mistake can be made than to suppose that the Porto Ricans are not able to exercise a positive voice in the determination of the laws under which they are to live or in the manner in which revenue shall be raised and expenditures made.

Two sessions of the legislature have now been held and a general scheme of local government throughout the island enacted. Some of the defects of the Spanish system were: innumerable districts or municipalities, a concentration of legislative and executive functions in the same hands, an innumerable number of offices, and as a result the expenditure of local funds for salaries, leaving no money for schools or roads, and the raising of revenue in such a way that the taxes were paid by the poor. All this has now been changed.

The number of municipal districts has been greatly decreased. A uniform system of keeping accounts for all the local governments has been put in force. The treasurer of the island has general direction over the finances of the district, and in case a district is not meeting its obligations can step in and assume control somewhat in the manner of a receiver of a corporation. The number of offices has been reduced and a law passed compelling the districts to devote a certain proportion of revenue to the schools and roads. The system of raising revenue has been entirely reorganized, and the revenue is now obtained from three main sources: (1) excise and license taxes on the manufacture and sale of rum, spirits, tobacco, etc, (2) a general property tax upon all real and personal property, with certain exemptions, and (3) a tax upon inheritances.

The revenue of Porto Rico is now from two and a quarter to two and a half million dollars per year, which is sufficient to meet all the expenses. At the end of the last fiscal year there was a balance of $230,000. The schools are now increasing in number, as the insular government devotes a certain percentage of its revenue to educational purposes, and this sum, taken in connection with what the municipalities have to provide by law, is sufficient to meet the requirements. The large amount of money devoted to the building of roads is resulting in an improved and definite system of highways.

In its industries Porto Rico is advancing favorably. The sugar and cattle industries are very flourishing; but the coffee industry is in a very bad condition, as the European market was lost when the island came under American sovereignty. The telegraph system belongs to the government. There is but one railway, now financed by American capital, but railroad building is progressing, and before long there will be a line from San Juan to Ponce around the west coast. An automobile service is in operation from Ponce to San Juan, running across the island.

At the conclusion of Mr Willoughby's interesting address, Acting President McGee called for remarks.

Dr David T. Day inquired as to the extent the English language was being introduced into the schools of Porto Rico. Mr Willoughby replied that English was being taught in every school on the island. The children were quick to learn it, as they liked it, and also because they were ambitious to obtain employment by the government or the large commercial establishments, where the ability to read and write English was often essential.

Mr O. H. Tittmann asked what were the relations of the Porto Rican delegate to our government. Mr Willoughby stated that the Porto Rican delegate to the United States Congress had the full powers of the territorial delegates.

Mr Tittmann asked if any attempt was being made to raise oranges and citrous fruits on the island. Mr Willoughby replied that attempts were being made, but that they were as yet in the experimental stage. There was no doubt, however, that the island is adapted to the cultivation of such fruits. The question was one of management, as to whether the efforts would be remunerative.

Mr Tittmann inquired whether the island of Culebra belonged to Porto Rico. Mr Willoughby replied that it did.

Mr Tittmann said that he wished to call attention to the fact that the United States had not only maintained the lights and buoys placed along the Porto Rican coast by the Spaniards, but had also placed additional lights, and through the U. S. Coast and Geodetic Survey had made a complete survey of the coast and the surrounding islands, and had charted most of the harbors in the island.

Mr Willoughby said he wished to emphasize the value to Porto Rico of the survey of the coast and harbors. A triangulation of the island and a careful survey were most necessary before the question of land titles and boundaries, which were now much involved, could be settled, and the work that had been done was an excellent beginning.

Mr R. L. O'Brien inquired why it was that Porto Rico received the custom duties and ex-

cise taxes collected on the island, while in other territories in the United States the revenue from these sources was turned over to the federal government. Mr Willoughby replied that it was impossible to raise sufficient funds from the island to develop and build up the country. Unless the revenue from excise taxes and custom duties was turned over to the insular government, there would be no funds available for the improvement of the island by schools and roads.

Mr H. M. Wilson directed attention to the fact that the interior of Porto Rico had no roads. The agricultural resources of the interior were not opened because pony paths and trails were the only means of communication with the commercial centers. He would like to know what was being done for the development of a highway system. Mr Willoughby replied that road-building was going on in ten or fifteen sections of the island. Each road was part of a general plan to open up industrial centers and to make a system of thoroughfares that would be most serviceable. The insular government expected much from the law which compelled municipalities to devote a certain percentage of their taxes to the improvement of the highways, especially as this money was expended under the general supervision of the insular authorities

Mr Amos W. Hart inquired as to the general danger in Porto Rico from hurricanes and tornadoes. Mr Willoughby replied that the danger was slight. The hurricane of 1899 was exceptional. There had been nothing like it in hundreds of years.

Mr Hart inquired as to the general direction of the trade winds. Mr Willoughby replied that his impression was that the trade winds were from the northeast. The trade winds made the climate comfortable at all seasons of the year.

Mr Theodore L. Cole wished to know how the experiment of intrusting legislative power to the executive heads of the departments was working. Mr Willoughby replied that the experiment was working admirably, as thus the executive heads had the opportunity of introducing and explaining measures which they thought of importance to their department.

Mr Richard U. Goode inquired as to what was the extent of the public lands and the nature of land tenure in the island.

Acting President McGee stated that before Mr Goode's question was answered he would like to direct attention to a very interesting fact about Porto Rico, namely, that the land-tenure system in Porto Rico had come up in slow and steady development from the aboriginals, who had no individual ownership. We have in Porto Rico an epitome in four centuries of the development of land tenure, a development which took two millenniums in Europe. He was especially glad this question was raised, and hoped Mr Willoughby would answer it in full.

Mr Willoughby replied that when the United States Government took charge of Porto Rico there was doubt as to whether the public lands went to the insular or federal government. This doubt had considerably retarded the development of the island, as there were considerable public lands waiting development near the cities. The extent of the public lands would not be known until an adequate survey was made. The last Congress passed a law stating that all public lands that the President does not select for military or naval purposes shall be turned over to the insular government. As to land tenure, private property was held there as in the United States, except that it was unusual to have land conveyed by deed. Land had been conveyed chiefly by descent, the result being that titles and boundaries were very much involved. A survey of the island, followed by a land-registration system something like the Torrens system, was much needed. Conveying of land was now very expensive.

Mr Theodore L. Cole inquired as to the difference between the political parties. Mr Willoughby replied that there were two parties, the Federals and the Republicans, both of whom accepted unhesitatingly American sovereignty and only differed as to the extent of authority to be left to the United States Government. The Federals wanted the Executive Council, which is now an appointive office by the President, made elective, thus taking it out of the hands of the American authorities. The insular government does not approve of such a course, as Porto Rico has not yet developed a sufficient sense of political toleration. The Republicans in general are satisfied with the existing system, though holding that in time the management of affairs should more largely be intrusted to natives of Porto Rico.

Mr Richard U. Goode asked whether the spelling of Porto Rico as *Porto Rico* (without the u) was generally accepted. Mr Willoughby said he could not answer definitely. The Americans all use the abbreviated form, but the people probably do not.

Mr J. T. Granger asked what was the opportunity in the island for the investment of money as loans. Mr Willoughby replied that though the general rate of interest was 9 per cent., only a limited amount of money could be safely placed in that way. Almost the only security the people could offer is land. As the matter of straightening out titles and boundaries proceeds the opportunity for loaning money will increase. The best openings

for capital are in the undertaking of direct-production enterprises.

Mr Granger asked if there were any national banks on the island. Mr Willoughby replied that one had just recently been organized.

Dr A. C. True stated that the U. S. Department of Agriculture was actively at work in several directions. The Bureau of Land Industry had collected much valuable information about the plants of Porto Rico. The Bureau of Soils had made a survey of a strip of land stretching across the island. The Bureau of Forestry had also made considerable investigations. A permanent experiment station had been established. The experiment station had received aid from the insular government, with which 200 acres of land for the headquarters had been purchased at Mayaguez. The experiment work at this station would be pushed as rapidly as possible. Mr Willoughby said the island was greatly delighted at the work of the Department of Agriculture and was expecting many valuable returns from the work.

Mr H. S. Williams directed attention to the fact that the Weather Bureau maintained an efficient climate and crop service in Porto Rico, which was investigating the influence of the climate on the crops there.

Mr Granger inquired as to the ranching facilities on the island. Mr Willoughby replied that this industry was very flourishing, though it had to compete somewhat with the sugar industry, as the land which is suitable for ranches is also adapted for cane. Cuba was sending to Porto Rico for many cattle, which fatten on the native Porto Rican grass without being fed on grain. The Porto Rican oxen make splendid draft animals. The cattle industry is very flourishing, and will continue so.

Mr Henry Farquhar inquired whether the Porto Rican cattle made good beef. Mr Willoughby replied that they made such very good beef that there was a considerable demand for the exportation of the cattle for meat.

Mr Farquhar wished to know if the island was not too densely populated for cattle-raising, as the density of the population was over 200 per square mile. Mr Willoughby said that he did not think so; that the density of population in Porto Rico does not impress one.

Mr Granger asked what was the estimated value of good cane land. Mr Willoughby replied that good cane lands brought from $100 to $150 an acre, and that the best land cost more than that, the price depending on irrigation.

Acting President McGee, in conclusion, stated that all present greatly appreciated Mr Willoughby's address and the supplementary information he had given in answer to questions. All present were to be congratulated on obtaining this clear and most instructive picture of our new island.

G. H. G.

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